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THE INCLUSION OF WOMEN IN STEM IN KUWAIT AND THE UNITED STATES

PROCEEDINGS OF A WORKSHOP

Dalal Najib and Paula Tarnapol Whitacre, *Rapporteurs*

Policy and Global Affairs

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

in Collaboration with

The Kuwait Foundation for the Advancement of Sciences

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**COMMITTEE ON PROMISING PRACTICES FOR
IMPROVING THE INCLUSION OF WOMEN IN
SCIENCE, ENGINEERING, AND MEDICINE:
LESSONS FROM KUWAIT AND THE UNITED STATES—
WORKSHOP SERIES**

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Preface and Acknowledgments

The United States and Kuwait are societies with distinct cultural and social traditions. Each has striking differences in the gender composition of science, technology, engineering, and mathematics (STEM) fields. Because the role and inclusion of women in STEM are governed by evolving sociocultural family and gender norms as well as educational structures and labor markets, it is important to examine this topic from a comparative U.S. and Kuwait perspective.

This volume is the outcome of the first of two joint workshops by the Kuwait Foundation for the Advancement of Sciences (KFAS) and the U.S. National Academies of Sciences, Engineering, and Medicine (the National Academies), bringing together more than 40 leaders in academia, government, and industry to discuss promising practices from Kuwait and the United States for improving gender equality in STEM. Topics included challenges and barriers facing women in STEM; recruitment, retention, and career development of women in STEM; curriculum and educational structure; gender stereotypes and gendered family roles; and mentoring and organizational change.

On October 28–29, 2019, the National Academies hosted the first workshop of this series in Washington, D.C. The workshop focused on challenges and barriers facing women in STEM; evidence of effective programs, practices, and models in both countries for recruiting women in science, engineering, and medicine; and curricula structure, and how it affects the attrition of women in STEM in the United States, Kuwait, and

the broader Arab world. The workshop was made possible thanks to financial support from KFAS. We would like to extend our appreciation to Dr. Adnan Shihab-Eldin, KFAS director general, and to Dr. Faiza Al-Kharafi, member of the KFAS board of directors, for their commitment to this effort.

We wish to extend sincere thanks to all the members of the planning committee for their contributions in scoping, developing, and carrying out this project.

This Proceedings of a Workshop was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies in making each published proceedings as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

We wish to thank the following individuals for their review of this proceedings:

Hayfaa Almudhaf, Kuwait Institute for Scientific Research (ret.)

Maria Charles, University of California, Santa Barbara

Lama Moussawi, American University of Beirut

Sana Odeh, New York University

Catherine Riegle-Crumb, University of Texas at Austin

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the content of the proceedings nor did they see the final draft before its release. The review of this proceedings was overseen by Marilyn Baker, the National Academies. She was responsible for making certain that an independent examination of this proceedings was carried out in accordance with the standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the rapporteurs and the National Academies.

Dalal Najib, Director

Science and Engineering Capacity Development Theme,

U.S. National Academies of Sciences, Engineering, and Medicine

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1

Introduction

Women in the United States and Kuwait have made advances as researchers and leaders in science, engineering, and medical disciplines, yet challenges and barriers remain to enter and advance in these fields in both countries. Building on recent collaborations, the U.S. National Academies of Sciences, Engineering, and Medicine (the National Academies) and the Kuwait Foundation for the Advancement of Sciences (KFAS) agreed on convening two workshops to identify evidence-based practices and resources for improving the inclusion of women as full participants in science, technology, engineering, and mathematics (STEM). Each workshop would involve about 40 leaders in academia, government, and business to focus on successful strategies and programs in both countries that increase opportunities for women. Understanding the context for both women and men would also be an integral part of the presentations and discussions. Workshop proceedings would be published in English and Arabic.

BACKGROUND OF THE WORKSHOP

Engagement between the National Academies and KFAS began in 2011 when KFAS supported the first Arab-American Frontiers of Science, Engineering, and Medicine symposium in Kuwait, which included U.S. participation. More recently, on October 23–25, 2017, KFAS hosted the 10-year anniversary edition of the International Conference on Women

Leaders in Science, Technology and Engineering under the theme “Science Empowers Women.” The National Academies was represented through its Committee on Women in Science, Engineering, and Medicine.¹ In 2018, KFAS collaborated again with the National Academies to host the sixth edition of the Arab-American Frontiers symposium in Kuwait City. The meeting convened more than 100 young scientists, engineers, and medical professionals from the Arab region and the United States to discuss new research advances in big data, air quality, water, the microbiome, and new buildings. KFAS host leaders expressed interest in the National Academies’ model and the extent to which Kuwaiti scientists and engineers could become more directly involved in helping investigate and influence key science-based policy issues in their country.

In 2019, KFAS Director General Adnan Shihab-Eldin met with National Academy of Sciences President Marcia McNutt and discussed ways to further consolidate an institutional partnership. Similar to the Arab-American Frontiers Program, they hope this series of workshops will pave the way for further collaborations between the National Academy of Sciences and KFAS.

ORGANIZATION OF THE WORKSHOP AND THIS PUBLICATION

The first workshop was held October 28–29, 2019, in Washington, D.C., and this proceedings summarizes the presentations and discussions at that event. The workshop was organized by a small planning committee working jointly to establish the agenda and identify speakers.

After welcoming remarks and presentations that highlighted the current situation of women in STEM in Kuwait and the United States, technical sessions included presentations from both Kuwaiti (and, in some cases, the wider Arab world) and U.S. perspectives. Sessions on the first day focused on the challenges and barriers facing women to enter and thrive in STEM as well as evidence of effective programs in both countries for recruiting women in STEM. A keynote address by Huda Akil, University of Michigan professor and recipient of the prestigious Kuwait Prize, closed out the first day of the workshop. On the second day, the third technical session highlighted the effect of curricula structure on the attrition of women in

¹ For more information, see <https://www.nationalacademies.org/cwsem/committee-on-women-in-science-engineering-and-medicine>.

STEM in the United States, Kuwait, and Arab world, and a concluding discussion among all participants closed out the workshop.

This proceedings presents highlights of the presentations and discussions and is organized to follow the meeting agenda. The workshop rapporteurs prepared it as a factual summary of what was presented and discussed at the workshop. The planning committee's role was limited to planning and convening the workshop. The statements made are those of the rapporteurs and do not necessarily represent positions of the workshop participants as a whole, the planning committee, or the National Academies.

INTRODUCTORY REMARKS AND CONTEXT

The workshop began with brief welcomes from committee co-chairs Hayfaa Almudhaf (Kuwait Institute for Scientific Research, KISR), and Sapna Cheryan (University of Washington). They laid out the general goal of the workshop to identify evidence-based practices to include women in science, engineering, and medicine.

Jim Hinchman, acting executive officer of the National Academies, observed that global challenges related to energy, health, and food supply cannot afford to sideline half of the world's population from helping to solve them. He noted that the workshop builds on work the National Academies is doing to address bringing more women into STEM fields. Adnan Shihab-Eldin, director general, KFAS, acknowledged that the gender gap reflected worldwide occurs in Kuwait, but noted the country's long history of advocating for women in education. Nawaf Al-Enezi, representing Ambassador Salem Abdullah Al-Jaber Al-Sabah, pointed to several memoranda of understanding between the United States and Kuwait related to education and science. He praised the workshop, which he noted falls under the embassy's theme of women's empowerment.

Women in STEM in Kuwait

As background to the ensuing presentations, Hayfaa Almudhaf, former senior advisor at KISR, provided a summary of the educational system in Kuwait, with an emphasis on women in STEM fields. Kuwait has a population of 4.2 million with a literacy rate of 95.7 percent. About 15 percent of the population is under the age of 15. The population skews to the middle years because of the high number of foreigners in the workforce. The general education system consists of four levels: kindergarten or nursery, primary,

intermediate, and secondary. Schooling at the primary and intermediate levels (ages 6 to 14) is compulsory, and all levels of state education, including higher education, are free. The Ministry of Education and the Ministry of Higher Education are involved in education policy and development.

Higher education is mostly provided by Kuwait University (KU), although there are also private universities and colleges. Major STEM institutions, in addition to KU, include KISR, KFAS, and the Dasman Diabetes Institution.

KU was established in 1966 and has 17 colleges offering 76 undergraduate and 71 graduate programs. Of its 41,000 students, 75 percent are female. Of note, STEM fields are overwhelmingly female. Within STEM colleges, 80 percent of the student body and 33 percent of faculty are female (see Figure 1-1). Among admitted students in medicine in 2019–2020, 84 percent of KU students were female.

The Ministry of Higher Education provides scholarships for the private colleges within Kuwait and to study internationally. Among those receiving Ministry of Higher Education scholarships to study outside the country, 49 percent are female.

Almudhaf briefly described the scope and missions of KISR, the Dasman Diabetes Institute, the Space Generation Advisory Council, and the Kuwait student chapter of the American Society of Civil Engineers. Females are well represented in each of these organizations, for example,

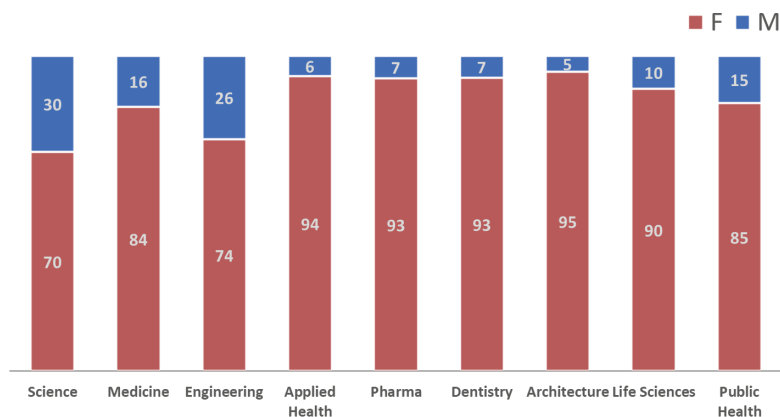


FIGURE 1-1 Gender distribution of admissions to STEM colleges at Kuwait University, 2019–2020.

SOURCE: Kuwait University.

garnering three of the first four scholarships awarded by the Space Generation Advisory Council.

KFAS acts as a catalyst to involve more women. It has helped support a Visiting Chair in Women and Societal Development Studies at the American University of Beirut and sponsors the Kuwait Prize, which has been awarded to several women. KFAS has convened conferences and events to bring together women leaders in science in the Arab world, Almudhaf noted, but “this is the first time the focus is on evidence-based practices, on systems, models, and strategies to empower women in the field.” She closed with an acknowledgment of the pioneering work of Faiza Al-Kharafi, former president of KU, recipient of the Kuwait Prize in Applied Sciences and the L’Oreal-UNESCO Award for Women in Science, and a chemist whose work has helped minimize the environmental impact of the country’s oil industry.

Women in STEM in the United States

Sapna Cheryan, professor of psychology, University of Washington, summarized the context in the United States, pointing out both similarities and differences with Kuwait. In the United States, women earn about 60 percent of undergraduate biology degrees, but less than 50 percent of degrees in chemistry and in mathematics/statistics. The numbers of women drop off at the master’s and doctorate levels in many STEM fields, with biology as a notable example. The percentages of women do not drop off as much in computer science and physics between the undergraduate and graduate levels, but the overall numbers are fewer (see Figure 1-2). Thus, issues of recruitment and retention differ across fields. “What this suggests, in the U.S. context,” she said, “is [that] the main issue for computer science, engineering, and physics is not as much retention as trying to get girls and women into these fields in the first place, whereas if you are a biologist, a chemist, or a mathematician, trying to increase representation by women focusing on retention might be a more effective strategy.”

By racial group, white women are the largest group receiving computer science, engineering, and physics degrees, although proportionate to their population, they are underrepresented compared with white men. “This shows that context matters,” she stressed, “not just between countries, but within countries.” Looking at technical jobs in Silicon Valley, women are vastly underrepresented. This means that women are missing out on potentially lucrative positions, and the field is missing out on the perspectives of women.

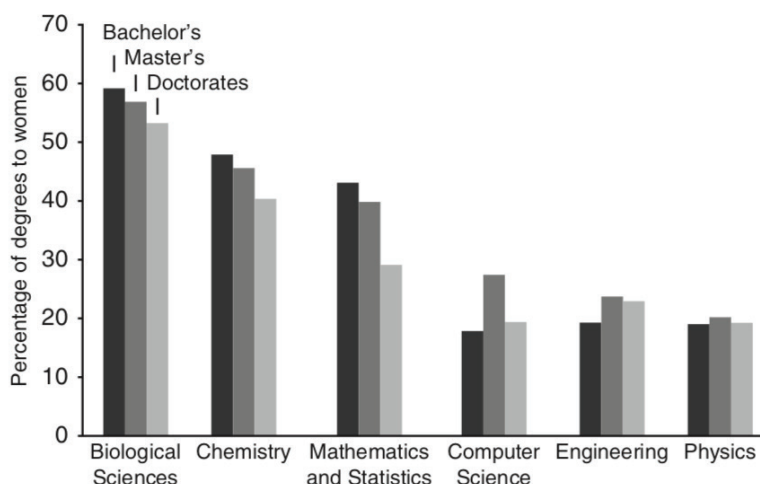


FIGURE 1-2 Percentage of bachelor's, master's, and doctoral degrees awarded to women in STEM fields in 2013.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System (WebCASPAR). Available at <https://webcaspar.nsf.gov>.

Cheryan pointed to several reasons for underrepresentation uncovered by researchers—many covered in greater detail throughout the workshop—that include socialization, discrimination, role models (and lack thereof), expectations of success, and work-family conflicts. Cheryan's own research points to the effect of media (e.g., the popular U.S. television show *The Big Bang Theory* starred four male engineers) and course-taking patterns in high school. The work indicates that women and girls feel a lower sense of belonging in computer science, engineering, and physics in the United States; in contrast, successful programs have created cultures that signal to women and girls that they do belong in these fields.

2

Challenges and Barriers Facing Women to Enter and Thrive

Women in the United States and the Arab world face challenges and barriers to their entry and success in science, technology, engineering, and mathematics (STEM). Challenges in the United States occur across the pipeline, from the youngest students to the highest levels of achievement. In contrast, in the Arab world, the percentage of women majoring in STEM is high—ranging from 60 to 80 percent. The main obstacles are related to career and social barriers. The first session of the workshop, chaired by Ameenah Farhan (Kuwait University) and Sapna Cheryan (University of Washington), investigated and discussed barriers related to stereotypes and career challenges, work-family issues, and the role of cultural ideologies in selecting careers.

Presenters to explore the Arab context included Nagwa El-Badri (Zewail City of Science and Technology, Egypt), Malak Abed AlThagafi (King Abdulaziz City for Science and Technology, Saudi Arabia), and Munirah AlAjlan (Kuwait University). The second half of the session focused on the United States, with presentations by Lin Bian (Cornell University), Adia Wingfield (Washington University in St. Louis), and Erin Kelly (Massachusetts Institute of Technology).

FUTURE ROAD MAP FOR THE IMPACT OF ARAB WOMEN IN STEM FIELDS

Nagwa El-Badri, director of the Center of Excellence for Stem Cells and Regenerative Medicine, Zewail City of Science and Technology

(Egypt), raised a theme referred to frequently during the workshop: Arab women are not underrepresented in STEM education and careers; but while positive examples of success by Arab women in STEM fields are abundant, participation is broadest at the base and tapers toward the top leadership positions. Her presentation focused on factors that lead to the decline of women's success in STEM as they rise in the ranks and offered a road map for better representation of Arab women in the STEM fields at all levels.

As an example of the benefits of involving women, a team of students in Cairo won first place in the Enactus World Cup held in Silicon Valley, competing against groups from around the world.¹ The mostly female team formed a social enterprise that markets and sells organic sanitary pads to rural women. El-Badri noted that the female participants could recognize and respond to a health and social need that affects more than half of women and girls in low- and middle-income countries.

Gender equality is important in STEM fields, she summarized, for five reasons: (1) Women deserve equal opportunity as a basic human right, (2) equality is necessary for sustainable economic growth, (3) women can better represent women's issues in STEM fields, (4) equality is important for power balance and can protect women from biases and bad behavior, and (5) women in higher academic positions can help improve academia.

Women remain underrepresented in research and development in every region of the world, ranging from 47 percent in Central and Eastern Europe to 19 percent in South and West Asia. As a point of comparison, women compose 37 percent of the STEM research and development workforce in the Arab States and 32 percent of researchers in North America and Western Europe, according to data from the UNESCO Institute for Statistics (see Figure 2-1).² The percentage of female students enrolled in higher education engineering, manufacturing, and construction programs is similarly low, with the highest concentrations in Latin America and Eastern Europe.

Considerations of the role of women in STEM must start with literacy, El-Badri contended. In the Arab world, literacy overall is rising and the gap between females and males is narrowing. In 2015, literacy among female youth ages 15 to 24 was 88.7 percent, compared with 77.4 percent in 1995. Literacy among male youth was 93.5 percent in 2015, compared with 88.5 percent in 1995.

¹ For more information about Enactus, see <http://www.enactus.org>.

² For more information, see <http://uis.unesco.org/sites/default/files/documents/fs51-women-in-science-2018-en.pdf>.

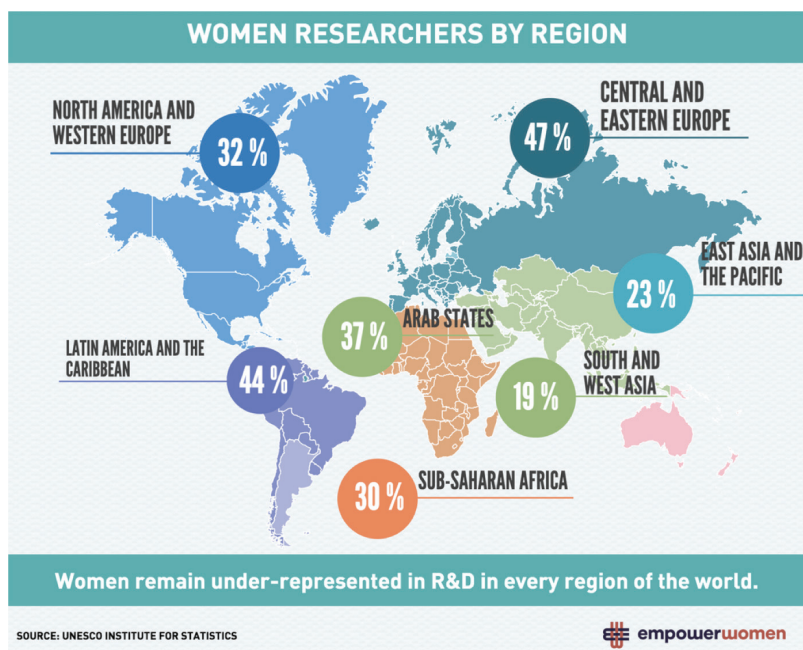


FIGURE 2-1 Female representation in research and development.
SOURCE: UNESCO Institute for Statistics.

El-Badri also noted “differences related to culture, socioeconomic status, and so on,” among countries considered part of the Arab world. There seem to be no barriers to women entering STEM fields in universities in many Arab countries, especially in natural sciences, health, and medicine, and especially in the Gulf States, including Kuwait. Women are well represented as educators in these universities as well. “The problem,” said El-Badri, “is the pyramid,” in which many women enter the workforce at the bottom but are much less represented at the top. This does not just occur in Arab countries, she pointed out. For example, in Canada, according to the Canadian Federation for the Humanities and Social Sciences, women constituted 58.2 percent of full-time undergraduate students but only 13 percent of university presidents. In contrast, men were 41.8 percent of the undergraduate population and 87 percent of university presidents. There are arguments for and against a quota to increase leadership opportunities, she noted.

The disparity does not just occur in STEM fields, and she referred to embedded systemic biases as contributing factors. Definitions of

“masculine” and “feminine” in the *Oxford English Dictionary* reveal some of these biases, for example. “What is holding women back from top jobs?” she asked. Several reasons, she said, referring to a 2014 Pew Research Center survey: Women are often held to higher standards, are deemed “not ready” for more senior positions, have family obligations, or have not been able to make sufficient connections. Focusing on the gender gap in STEM fields, research has pointed to gendered socialization, the influence of peer groups, stereotypes of STEM professionals, institutional bias, and family responsibilities.³

El-Badri then turned to an Egyptian case study on supports and barriers for gender equity in STEM education. According to qualitative interviews, family and social support and barriers; personal qualities of self-efficacy, persistence, and resistance; and school-level support and barriers all play a role in women’s participation in STEM. In sum, challenges include the following:

- Ignoring the success of women.
- Enforcing women’s traditional roles.
- Lack of perception by many women to view challenges in promotion as discriminatory.
- Reluctance by many female scientists to introduce the gender factor as relevant to their work.
- Portrayal of women in the media.

To El-Badri, media portrayal is a particularly important factor. Women are rarely portrayed as successful competitors, including in science. Women scientists should be presented as role models in media (especially television and social media), mentoring programs, and educational materials. Recognition, including special awards for women in STEM, grants for girls, and work reentry grants, are also important, she suggested. An important first step, she concluded, is simply ensuring that women’s first names are included in articles, books, and other materials.

³ Reinking, A., and B. Martin. 2018. The gender gap in STEM fields: Theories, movements, and ideas to engage girls in STEM. *Journal of New Approaches in Educational Research* 7(2). <https://naerjournal.ua.es/article/view/271>.

HOW TO LEAD FEMALE RESEARCHERS IN A MALE COMMUNITY

Malak Abed AlThagafi, director of the Saudi Human Genome Lab, King Abdulaziz City for Science and Technology (Saudi Arabia), is a scientist, physician, and entrepreneur who returned to Saudi Arabia after studying at three postgraduate institutions in the United States. When she returned 4 years ago, she established a laboratory in Riyadh, a city unfamiliar to her. She agreed with the view stated by others that women in STEM are more affected by promotion than entry-level issues in the Arab world, including Saudi Arabia, and that women in science who are striving for positions of power face challenges. As a new principal investigator, she had to wear multiple hats related to management, budgeting, research, and other areas. In addition, she said, “As a new leader, I also had to choose which leadership style to wear.” She chose a strategy known as *intentional leadership*.

AlThagafi’s genomics lab at King Fahd Medical City began as an all-female team and now, several years later, the researchers and other team members (including a genetics counselor and pathology resident) are almost all women. Intentional leadership embodies three strategies: to foster self-esteem, encourage collaboration, and support mentor programs for herself and members of the lab. She finds that her female colleagues strive for harmony, are confident and intelligent, and want to change stereotypes about women’s abilities and success. She stressed the importance of mentors, especially for female scientists, to help identify and address misconceptions and create a strong, inclusive research environment in a traditionally masculine community. Mentorship can counteract the lack of role models for many female researchers and overcome the confidence gap when women question their own abilities.

AlThagafi noted the importance of mentors in her own career, including a physician who treated her in Saudi Arabia and a professor at Georgetown University. Science empowers women, AlThagafi stressed. It helps women around the world, including in the Arab world, build bonds with each other and achieve success.

NARRATIVES OF WOMEN IN A MAN’S WORLD

Munirah AlAjlan, an English as a Second Language instructor at the College of Engineering and Petroleum, Kuwait University, presented a sociolinguistic case study of female engineering students at Kuwait University. To design the study, AlAjlan drew on previous research that investigated

women in engineering, as well as studies that confirm the role of a narrative approach in research. Her study took place at Kuwait University College of Engineering and Petroleum.

The study used semistructured, one-on-one interviews with six female engineering students about their experiences at Kuwait University. They were all 22 to 23 years old and in their fourth, or senior year, at the college. The analyzed data included generic stories to which the women would respond. AlAjlan drew on the three levels in Bamberg's Positioning Theory:⁴ (1) positioning the self in the story world (i.e., how speakers construct their identities within the events of the story they tell), (2) positioning the self in the interaction world (i.e., how speakers construct their identities with the listeners), and (3) positioning the self in the circulating discourses (i.e., how speakers construct their identities according to the cultural and master narratives in society). The researcher coded the interviewees' responses to see how they related to these three levels. The study also used the interviewees' comments to try to answer three research questions:

1. How do the biographical accounts that were narrated in the interview assist the interviewees to position themselves and others within the narrated events?
2. How are the women in the study positioned as engineering students in the research interview setting?
3. How do the women in the study construct a female engineering identity toward the wider discourses of being females in the engineering context?

AlAjlan categorized the women based on Josselson's Theory of Identity Development in Women as gatekeepers, pathmakers, searchers, and drifters.⁵ AlAjlan said she chose slightly different categories for the Kuwaiti women according to the narratives they told. "Assertives" stated they chose the engineering profession and are seeking a career in the field. "Trailblazers," in addition to proving their ability in engineering, wanted to go beyond the default to excel in their profession. "Drifters" did not intend to continue with an engineering career. AlAjlan also identified several of the women as feminists who are more politically active in seeking gender

⁴ Bamberg, M. 1997. Positioning between structure and performance. *Journal of Narrative and Life History* 7:335-342.

⁵ Josselson, R. 2017. *Paths to Fulfillment: Women's Search for Meaning and Identity*. New York: Oxford University Press.

equality. Overall, she said her analysis of the narratives revealed that the women are ready to join in with male counterparts in the various areas of engineering and reject notions that they are insecure in their profession.

AlAjlan plans to use Josselson's identity development model and investigate the women's identities over time.

DISCUSSION

In a discussion session, presenters and others around the table addressed the differential career paths between women and men in Kuwait. Many men in Kuwait go into the military, positions within the Ministry of Interior, or private business. One participant suggested, based on her own observations, "Women tend to be more conservative and seek academic or government jobs, while men, especially younger men, are more open to entrepreneurial jobs. We have to train women that academic and government jobs are limited, and they have to be more open to the whole range of opportunities." Yet another participant pointed to generational differences; in her view, younger women are embracing change. More males than females also go abroad on Ministry of Higher Education scholarships. El-Badri said more men study abroad in Egypt as well, often because of a family's opposition to the daughter leaving. AlThagafi said the percentages are about the same in Saudi Arabia.

One participant referred to the higher entrance and attrition rates in the biological sciences compared with math and physics in the United States. "In my [older] generation, the barrier to entry was higher. Women scientists walked in knowing it was going to be hard, so we were sort of immunized to the adversities and were prepared," she observed. She wondered whether this characterized math and physics today, thus leading to fewer entry-level numbers but also lower attrition. "Perhaps this workshop could discuss strategies to develop resilience to adversity, especially for women who are unaware of the situation when entering the field," she suggested.

Referring to the Arab context, women have an additional challenge in finding work and advancing. "Some women remain stuck," said one participant. "Men have an additional advantage to network and collaborate outside of business hours. That's how they can get supported and connected to leaders in nonformal ways."

A professor commented that while the medical school student body at Kuwait University has more females than males, the females tend to go into family medicine and other less surgical specialties. "This could be a

preference from the female students themselves, or it could be resistance from certain subspecialties that are considered more masculine,” she said. “Mentorship is definitely lacking in higher ranks.” Although she has not studied this conclusively, she also noted that women retire younger than men in Kuwait, thus removing these role models from the workforce earlier.

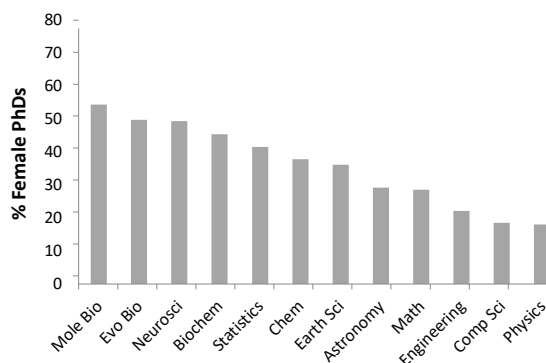
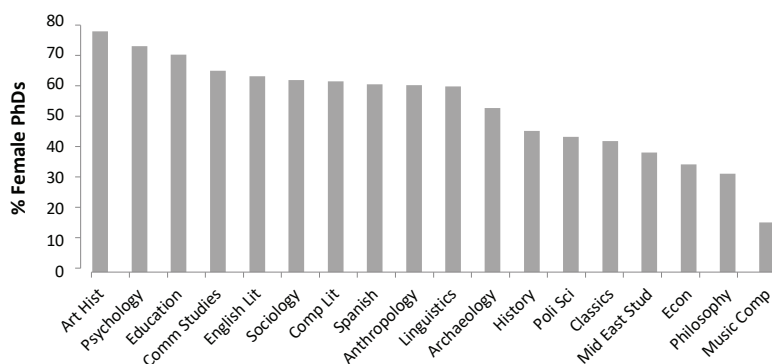
CHALLENGES AND CONSEQUENCES OF THE “BRILLIANCE=MEN” STEREOTYPE

Lin Bian, assistant professor in the Department of Human Development at Cornell University, has focused her research on trying to explain gender gaps in the STEM domain and variability within STEM and non-STEM domains. As context, she noted that women tend to be better represented in some fields than others. In STEM fields, for example, more women pursue biology compared with computer science and physics. Similarly, in non-STEM fields, women are well represented in art history and psychology, but are outnumbered by men in economics, philosophy, and music composition (see Figure 2-2). The hypothesis for the gap rests on two factors: First, the “brilliance=men” stereotype assumes that women are not as likely as men to be brilliant or intellectually gifted. Second, according to field-specific ability belief theory, certain fields require a “spark of genius.” Cimpian and colleagues found initial evidence of this theory through a nationwide study of about 1,800 academics in 30 disciplines.⁶ The academics were asked to rate aptitudes needed in their given field and the extent to which a “special aptitude that can’t be taught” is required. The results show that the more a field emphasizes brilliance, the lower women’s representation is at the Ph.D. level.

Bian and her team investigated the developmental roots of the gender gaps, and how brilliance came to be more associated with males than females.⁷ She summarized three studies: (1) What is the development of the gender stereotype about brilliance? (2) How does the gender stereotype affect girls’ interest toward activities that require brilliance? (3) How does gender stereotype affect children’s bias against other activities requiring brilliance?

⁶ Leslie, S. J., A. Cimpian, M. Meyer, and E. Freeland. 2015. Expectations of brilliance underlie gender distributions across academic disciplines. *Science* 347(6219):262-265.

⁷ Bian, L., S.-J. Leslie, M.C. Murphy, and A. Cimpian. 2017a. Messages about brilliance undermine women’s interest in educational and professional opportunities. *Journal of Experimental Social Psychology* 76:404-420.

STEM**Non-STEM****FIGURE 2-2** Variability within STEM and non-STEM domains.

SOURCE: National Science Foundation (2011). Survey of Earned Doctorates. Available at <http://www.nsf.gov/statistics/srvydoctorates>.

Gender Stereotypes and Brilliance

In the first study, 48 boys and 48 girls ages 5 to 7 were shown a photo of a man and a woman. They were asked to select which person was smart and which was nice. Boys in the three age groups were more likely to choose the male as smart, as did girls once they reached age 6. When shown photos of children and asked who did better in school, girls were more likely to think the girls received better grades. Bian said the results indicate that even though girls perceive that girls do better in schoolwork, it does not buffer against the belief that boys are smarter. If children's perceptions about grades

are not the sources of their stereotypes, this opens up questions as to where they do look to infer intellectual differences between men and women. Bian summarized the study as follows: (1) at the age of 5, both boys and girls attribute more intelligence to their own gender; (2) starting at the age of 6, girls become less likely than boys to associate intelligence with their own group; and (3) girls' endorsement of this stereotype is unrelated to their perception of school achievements.

Gender Stereotypes and Girls' Interest Toward Activities that Require Brilliance

Bian's second study attempted to answer whether this negative stereotype affects young girls' motivation, leading them to avoid activities said to require brilliance. In this study, 64 6- and 7-year-olds received descriptions of two games, one described as for children who are "really, really smart," and the other for children who "try really, really hard."⁸ They were asked if they would want to play the games, with the prediction that the girls would show less interest toward the "really, really smart" or "brilliance" game. While boys and girls favored the hardworking game to the same extent, the messages about the importance of being smart undermined the girls' motivation to choose the brilliance game.

In a related set of questions, the children were told about a really smart child and asked whether the child was a boy or a girl. The girls were less likely than the boys to guess the smart child was their own sex, which was related to their lower interests toward the brilliance versus the hardworking activity. In summary, (1) 6- to 7-year-old girls' interests toward an activity was undermined by the messages emphasizing the importance of being smart, and (2) young children's beliefs "about who is likely to be brilliant are one of the factors that guide their decisions about which activities to pursue."

Gender Stereotype and Children's Bias

The third study involved 192 children ages 5, 6, and 7 to determine whether this negative stereotype affects children's evaluations of girls' competence in activities said to require brilliance. In this study, the children were

⁸ Bian, L. 2017. The roots of gender gaps: Investigating the development of gender stereotypes about intelligence. Ph.D. thesis, University of Illinois at Urbana-Champaign. Available at <http://hdl.handle.net/2142/97324>.

presented with two games, one of which required someone “really, really smart,” and asked to form a team. They then chose from six photos (three girls, three boys) whom they would want on their team. Fewer girls were chosen for the game requiring brilliance, including selection by other girls.

Conclusions and Future Studies

Across the three studies, Bian drew the following conclusions:

- The negative stereotypes about women’s intelligence begin to be assimilated in the early elementary-school years.
- This stereotype immediately begins to affect girls’ activity choices, leading them to avoid the activities described as requiring brilliance.
- This stereotype also leads children to exhibit bias against females in contexts perceived as requiring brilliance.

Current and future studies will look at the sources of this stereotype and how to block its negative effects. For example, the extent to which parents, teachers, and peers have an influence will be further explored.

CHALLENGES OF BLACK WOMEN IN THE HEALTH-CARE INDUSTRY

Adia Wingfield, professor of sociology at Washington University in St. Louis, compared the characteristics of the U.S. working world today with that of the period after World War II. Previous decades offered job security and little turnover, competitive benefits, a robust middle-management sector, but also occupational segregation. Today’s working world offers less job security, flatter organizations, and lower employer-provided benefits, but also more stated support for racial diversity. Today’s “new economy,” as referred to by economists and sociologists, is a transition from a manufacturing economy to a service economy, with policies that encourage minimal regulation, free markets, and the growth of new technology and innovation. Research into the new economy shows a “frayed contract” between management and labor, with higher levels of workers’ stress and uncertainty. Professional work that is based on technological advances and the knowledge economy remains one of the few routes to economic security, Wingfield said. “Professional work is also the focus of what I call

the *diversity dialogue*,” she added. “There is more discourse about creating diversity in professional occupations.” Wingfield has looked at how Black professionals in the United States have navigated the new economy, with a focus on Black women in health care.

The health sector reflects economic and cultural changes, is the site of both good and bad jobs, and offers dwindling support for public-sector care, Wingfield said. While Black women remain underrepresented in most health-care professions, the field is trying to diversify. Just as Black women started to gain access, the rules of the new economy, with little institutional support, have taken hold, she stated. They face a number of barriers, including stereotypes about their reliability and lack of access to mentoring.

Black women are about 3 percent of M.D.’s and 9 percent of nurses. Her study involved intensive, semistructured interviews with 75 health-care workers, including doctors, nurses, physician assistants, and technicians. She also drew from TAPS, the American Panel Survey, and conducted field observations in three settings. The findings differed by occupation within the sector, as follows.

Black women doctors cited infrequent experiences with overt racism, although race affected them through structural and cultural processes. Instead, gender became more salient, with women physicians (Black and white) often assumed to be nurses.

In contrast, Black women nurses work in a culturally feminized profession, and they shared many more accounts of explicit, interpersonal racism from colleagues. “Black nurses talked about structural racism being present when it came to scheduling and educational requirements,” Wingfield explained.⁹ Unlike with the physicians, she said, “they did not receive reminders that as women, they did not belong in the profession, but they received plenty of reminders that as Black women, they did not belong in the profession.”

Black women technicians worked in the least overtly gendered of the three professions but, as technicians, had the least control over their work. Black women and men both cited explicit racial encounters, and women in the sample were more likely to quit as a consequence of those encounters, or they viewed technician work as a stepping stone to what they perceived as a higher-status position as a nurse.

⁹ Wingfield, A., and K. Chavez. 2020. Getting in, getting hired, getting sideways looks: Organizational hierarchy and perceptions of racial discrimination. *American Sociological Review* 85(1). Available at <https://journals.sagepub.com/doi/10.1177/0003122419894335>.

Wingfield drew the following conclusions from her study:

- Gender issues facing Black women in health care are inextricably linked with race.
- Equally importantly, they also vary by occupational position.
- Efforts to foster diversity in health care must attend to the different issues across positions.
- Work in the new economy requires reviving institutional supports/resources in order to provide a functional work environment for Black women in medicine.

Increasing the number of women and racial minorities in the health-care professions could also improve health-care outcomes, she noted.

GENDER AND CAREERS: WORK-FAMILY CHALLENGES, CHOICES, AND INTERVENTIONS

Erin Kelly, professor of work and organization studies at the Massachusetts Institute of Technology Sloan School of Management, drew from her own research and other U.S. literature on work-family issues as a challenge to women's experiences in STEM. "As a sociologist, I take a structural perspective to understanding those challenges," she said. "From a gendered organizational perspective, I look at what happens within workplaces once people get to them." She discussed how the "ideal worker norm" creates a structural barrier to women's advancement in the workplace. She then described a cluster-randomized trial of an intervention she conducted in a large company that shifted norms and created more flexibility for women and men.

False Notion of Choice

Research shows the structure of careers in the United States is built around men's experiences, Kelly stated, in particular white middle-class males' experiences. Employees are expected to prioritize paid work above all else, such as by working long hours, relocating when requested, and always making themselves available. It is challenging to meet these norms and raise a family in all fields, including as STEM professionals. Because women are more engaged in child care and housework in the United

States, many “choose” to leave their careers. But, Kelly contends, this is a constrained choice. Using the rhetoric of “choice” makes this decision seem “not discriminatory.”

Becoming a parent increases the risk of exit from a STEM career. According to one survey, 43 percent of mothers and 23 percent of fathers left the field.¹⁰ Comparing women in STEM with women in other professional jobs shows a dramatic difference in retention of more than 800 percent, with an advanced degree increasing the odds of exit. “We still can’t explain why there is such a dramatic difference in retention,” Kelly said. “Something is triggering even highly satisfied women to leave.”

Changes to the Ideal Worker Norm

Kelly and colleague Phyllis Moen were involved in research funded by the National Institutes of Health, Centers for Disease Control and Prevention, and several foundations to study how work, family, and health are interrelated; evaluate workplace changes that might benefit workers, families, and firms; and change the public conversation around these issues. Six studies took place.¹¹ Kelly focused her presentation on one of these studies that involved an experiment among professionals in a large information technology company.

A simple flexible work policy is not sufficient, they concluded, as it provides limited access (supervisors needed to approve its use), and utilization is often low because of stigma and career penalties. Instead, they designed a “dual-agenda work redesign initiative” that involved teams sitting together to talk about work expectations and practices. Changes that could work well for the organization and employees (women and men) were identified, such as more opportunities to work from home and more flexible practices. A year later, a randomized control trial showed that men’s and women’s job satisfaction, sleep, a sense of control, and other benefits all increased, while burnout, plans to leave the company, and other negative factors had declined. The changes particularly improved women’s stress and distress levels. “This is a gender-neutral workplace change that ended up also improving women’s well-being,” Kelly said.

¹⁰ Cech, E., and M. Blair-Loy. 2019. The changing career trajectories of new parents in STEM. *Proceedings of the National Academy of Sciences* 116(10):4182-4187. DOI: 10.1073/pnas.1810862116.

¹¹ For more information, see <http://workfamilyhealthnetwork.org>.

Kelly drew five conclusions from the research:

- It is important to look at what happens within work organizations to understand retention, who thrives, and who struggles.
- Work-family conflicts are part of the story, but other forms of bias are also at play.
- “Choices” to leave after family transitions are constrained and reflect gendered ideal worker norms.
- Current work practices and career structures do not work for many women *and* men.
- The aim should be to change the workplace, not change the workers or recruit the “right” workers.

DISCUSSION

Participants asked Lin Bian about race and ethnicity in her brilliance research. In the Kuwaiti context, noted a participant, class and other intersectional issues could also play a role. At this point, all photos used in the brilliance studies are of white adults and children, although both majority and minority children of different socioeconomic classes were queried. She said there seemed to be less of a discrepancy when photos of African American men and women were shown, and Asian women were seen by some children as smarter than Asian men. Toys targeted at girls and boys could also play into these early perceptions, a participant suggested. Bian said she knew of a study looking at descriptions of toys on the Amazon website, but she has not studied this. She and her team are considering introducing different toys or games as one way to test some of these assumptions.

In response to a question, Erin Kelly said she did not know of research that follows whether women who leave STEM return to the field. She pointed to one researcher who has looked at professional women re-entering the workplace (not necessarily STEM) and found they tend to go into nonprofit or other work with a social mission. Related to the workplace intervention she described, her team followed the employees for 3 years. The company was acquired and did not continue the practices.

3

Evidence of Effective Programs, Practices, and Models for Recruiting Women

The positive representation of women in science, technology, engineering, and mathematics (STEM) influences the number of women who are recruited into STEM in Kuwait and the United States. The workshop's second session explored evidence of effective programs, practices, and models in Kuwait and other Arab countries, as well as in the United States, to attract and retain women in science, engineering, and medicine. Chaired by Hayfaa Almudhaf (Kuwait Institute for Scientific Research) and Sonya Smith (Howard University), the discussion tackled such issues as identification of the barriers that prevent women from rising to the higher levels of the field; gender bias in recruitment/selection and in decision making; the work environment in which women work in male-dominated industries; and models of success to build the academic prowess, self-confidence, and leadership skills for women in STEM. While some successful strategies to improve opportunities for women were provided, the session did not include a discussion solely on strategies. The latter will be addressed at the second workshop.

In the first part of the session, presentations were made by Lama Moussawi (American University of Beirut), Amani S. Bu-Qammaz (Kuwait University), and Ikhlas Abdalla (Kuwait University). They were followed by Janet Malley (University of Michigan), Alice Hogan (consultant, formerly with the National Science Foundation), Yasmine Kanaan (Howard University), and Dara Norman (National Optical Astronomy Observatory).

The day concluded with a keynote address by Huda Akil, University of Michigan professor and recipient of the Kuwait Prize.

BEACON ON A HILL: FROM AUB TO THE ARAB WORLD

Lama Moussawi, associate professor at the American University of Beirut (AUB) in Lebanon, noted how the large worldwide gender gap in women's economic participation and empowerment affects the Middle East and North Africa (MENA). Globally, gross domestic product would increase by \$55.3 trillion by 2025 if the economic gender gap decreased by 25 percent. Women generate just 18 percent of gross domestic product in the MENA region, compared with 40 percent in other parts of the world. Women are mostly represented in lower-productivity sectors such as agriculture.

As discussed throughout the workshop, women in the Arab Middle East are equipped with knowledge, skills, and abilities, including in STEM, yet have trouble securing employment and advancing in their fields.

In the United States and other parts of the world, women are faced with a “leaking pipeline,” in which they enter STEM fields but face challenges to retention and advancement. In contrast, Moussawi said, Kuwait and several other Arab countries are characterized by a “bursting pipeline.” In other words, many women receive a STEM education but face barriers and disadvantages that preclude access to formal employment and legitimate roles in the formal economy. The situation is exacerbated by a large youth population, and thus high youth employment. Female youth are the most disadvantaged.

Moussawi highlighted two initiatives at AUB to move toward more gender-inclusive organizations: Women in Data Science (WiDS) and the Center for Inclusive Business and Leadership for Women, or CIBL.W.

Data Science as an Avenue for Women

Data science is a growing field, and data scientists are in high demand. Yet, women's involvement in computer science and engineering, two key paths to data science, has declined. To encourage more women to enter the field, WiDS began at Stanford University and now has more than 150 locations worldwide, including at AUB as a regional hub. “WiDS@AUB” creates a platform for data scientists in the Arab Middle East, promotes higher representation of women in data science, exposes the latest data science

research and practices, allows for the exchange of ideas, supports mentorship and collaboration, and connects regional researchers and practitioners to global data science networks. AUB has convened an annual conference, technical talks, roundtable sessions, and outreach. Participation in the conference has grown each year, so that it is now one of the largest conferences at AUB and the largest hub for data science in the region. “At WiDS AUB, we are presented with an opportunity for change, and we make sure that we create an inclusive culture that supports women,” Moussawi said.

Center for Inclusive Business and Leadership for Women

The second initiative that Moussawi discussed is the CIBL.W. It seeks to lead change in developing female talent and achieving gender-inclusive businesses across the region by preparing them to hire more women. The center focuses on behavioral, perceptual, and systemic changes through capacity building, change mobilization, and organizational policies and systems. It works with business partners, policy makers, gender and other ministries, think tanks, civil society, media, and the donor community.

Data collection is important in order to make changes under the assumption, Moussawi said, that “if you can’t measure it, you can’t change it.” A current project, funded by the U.S. Department of State Middle East Partnership Initiative, is to develop the first local data-driven index, called the KIP Index, “capturing nuances and heterogeneity of the situation of women in Arab MENA economies and translating multi-lingual knowledge into a measurable set of dimensions.”¹ The vision is to use data for regional impact, such as to equip managers to make decisions related to women in STEM professions and to influence policies. Preliminary results are being compiled. A second grant, to start soon, will strengthen women’s contributions to the economy in the MENA region.

PIONEERING THE EMPOWERMENT OF YOUNG FEMALE ENGINEERS IN KUWAIT

Amani Bu-Qammar, assistant professor in civil engineering at Kuwait University, discussed the group Kuwait’s Engineer Girls (KEG). The company Limak İnşaat Kuwait reached out to Kuwait University to establish the

¹ For more information, see <https://www.aub.edu.lb/osb/research/CIBLW/Pages/KIPIndex.aspx>.

program, adapted from a similar program in Turkey. The training aims to empower young female engineers to thrive in the private sector in Kuwait and to contribute to the country's 2035 vision. Female senior students in Kuwait University's College of Engineering and Petroleum are targeted. The "first generation" was launched in 2017, and two generations, or groups of 30 students each, have followed.

Participants gain such skills and characteristics as time management, self-esteem, communications, and problem solving. They participate in training courses, seminars and workshops, field trips and other site visits, and interactive learning sessions. Participation requires an application process and commitment, with only 30 spaces available per cohort. They are involved in 200 hours of training during the fall semester of the academic year. A critical follow-up is the creation of a strong community.

An outcome assessment of the first two generations of KEG participants shows improved self-esteem, leadership development, and critical thinking. Overcoming cultural barriers was less significant, but she pointed to the relatively short duration of the training as a reason why. As follow-up, the young women received three well-recognized certifications and traveled as a group to Istanbul. "We look forward to future generations and to expand the program to other companies," Bu-Qammaz concluded. KEG can also foster connections among the women as they continue their careers.

PERCEIVED MACRO AND MESO BARRIERS TO KUWAITI WOMEN'S CAREER ADVANCEMENT

Ikhlas Abdalla, professor of management at Kuwait University, presented on research conducted with collaborator Asmaa Al-Kandari. Referring to the concept of a bursting pipeline rather than a leaking pipeline to characterize women's involvement in STEM professions in Kuwait, she noted the literature identifies such drivers as sociopolitical forces, country-wide human resource management practices, forces within organizations, and employees' own actions and personalities (see Figure 3-1).

The research sample consisted of 95 STEM women, 92 STEM men, and 140 non-STEM women working in medium and large Kuwaiti organizations. Ages ranged from 24 to 49. Abdalla focused her presentation on the items in the survey instrument related to perceived macro sociopolitical barriers and human resource management.

The researchers found agreement by women and men that the most important sociopolitical barrier is lack of legislative support. There was also

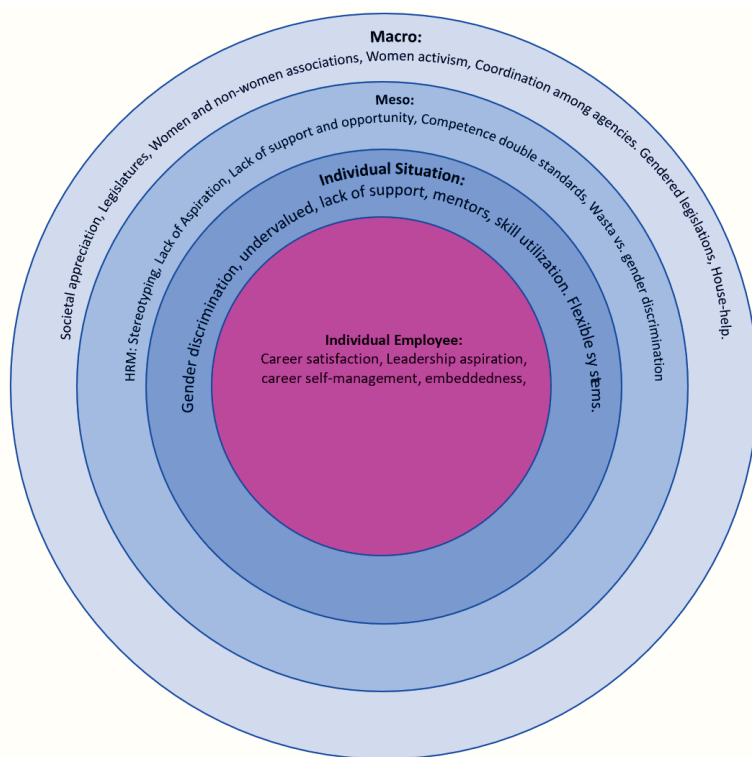


FIGURE 3-1 Multilevel environment barriers of women's career advancement.

SOURCE: Data provided by Ikhlas Abdalla and Asmaa Al-Kandari, Kuwait University.

gender agreement about low societal appreciation of women's economic contributions. The least important barrier identified by both genders was the adequacy of child care and domestic help.

Female respondents, more than males, faulted the inadequacy of female activism and weak women's organizations. Women more than men also noted the lack of coordination among agencies on issues of women's empowerment.

The survey revealed a gender gap in human resource management issues. The most important barrier—more serious than gender discrimination—was identified as *wasta* (nepotism), in which *wasta* and social connections are more important to gaining a position than competence and gender discrimination. *Wasta* can cancel the adverse effects of gender bias, respondents said, but helps men more than women. The use of double standards was also

seen as a barrier and a form of gender discrimination. Stereotyping, biased opportunities, and doubting women's aspirations were also factors.

Looking at gaps between STEM and non-STEM women, both groups of women held similar views related to *wasta*, double standards, stereotyping, a lack of career aspiration, and proactivity. STEM women stressed lack of support and opportunities more than non-STEM women.

"What the data is telling us," Abdalla said, "is that there is opportunity to apply more pressure on legislatures, engage women more actively, and start conversations with men and women to correct the misconception that women lack career aspirations." She urged women to publicly express their aspirations and engage in career self-management. Since the Arab Spring of 2011, she said, women have been rebelling not only against dictators but also against a conservative mindset that fears women as agents of change.

DISCUSSION

Regarding laws to change (raised as an issue in the study mentioned above), Abdalla said the Kuwait Constitution supports equality and the government is pro-women, but laws are not always enforced. "There is also pressure from religious conservative centers," she added. "A conspiracy of silence exists when laws are broken." In some cases, practices changed when women brought issues to court, such as the previous quota that limited how many women could enter medicine and other STEM fields at Kuwait University.

"The bursting pipeline means that women come into STEM fields with plans but then must give them up," said one participant. She asked about any interventions to change perceptions at a younger age about future capabilities for males and females. Abdalla did not know of any specific studies, but pointed to recent government data that show that in times of economic difficulty, men and women do not show a preference to *educating* their sons over their daughters. However, in times of difficult economic conditions, they stated a preference to *giving a job* to a man over a woman. That is why it is important for girls to have supportive fathers and brothers, she and other presenters stressed. "A recurring theme is that culture is pervasive, and involvement of men is important as family members, in leadership positions, or as mentors," observed a participant.

Another participant noted the importance of instilling self-esteem in young women and asked about tools to measure this in the KEG Program. Self-esteem is not taught as a separate course but as an integral aspect of the

entire program, Bu-Qammaz explained. She remains in contact with most of the previous participants, and several have told her about changes that have occurred in other aspects of their lives.

In answer to a question about why women continue to enter STEM in Kuwait with limited employment possibilities, Bu-Qammaz clarified that women do find entry-level jobs but have limited promotion opportunities and quality of work. For careers that require field work, women are constrained in how they can work with laborers and others. Some may work in something STEM-related but not the specific field in which they majored; for example, one participant knew of several engineers working as health instructors.

EFFORTS TO IDENTIFY AND IMPLEMENT DATA-DRIVEN POLICIES AND PRACTICES THAT INCREASE DIVERSITY AND RETENTION

As the first of four presenters focusing on U.S. issues, Janet Malley, director of research and evaluation for the University of Michigan ADVANCE Program, discussed policies and practices to increase faculty diversity at the University of Michigan through the ADVANCE Program. As also detailed more fully in the next presentation, it began with 5-year funding by the National Science Foundation (NSF) and a focus on information technology in 2002. In 2007, ADVANCE was internalized within the university with the same level of funding and a broader mission to work toward all forms of diversity and in all fields. It reports to the provost, with oversight by a steering committee chaired by the university president, provost, and dean of the medical school.

The goal is institutional change at all levels—individual, department, college, and university. Through data-driven policies and practices, the program aims to increase the diversity and excellence of faculty recruited, improve the climate for a retention of a diverse faculty, and support leadership development and success. The strategy is to change the culture, not “fix the women.” Malley said the first task was to understand the pipeline. The program held a 4-day workshop for postdocs and advanced Ph.D. students designed to encourage those with a commitment to diversity to consider an academic career.

Departmental practices were addressed through the Strategies and Tactics for Recruiting to Improve Diversity and Excellence (STRIDE) Program. Distinguished senior faculty were involved to serve as credible

sources. Expertise about search practices was developed and offered in campuswide workshops for faculty and administrators. Workshops offered conceptual tools, empirical evidence, and practical solutions. The percentage of STEM women faculty before STRIDE was 13 percent; it increased to 31 percent (see Figure 3-2).

Two studies looked at the hiring process. The first aimed to understand the extent to which search committees used the strategies and practices suggested by STRIDE. The second was related specifically to the interviewing process to learn what departments could do differently. Five recommendations resulted, namely:

- Convey the specific value of the candidate to the department.
- Make offers on fast and clear timelines and as generous as those at other institutions.
- Include opportunities to meet with prepared students and other women faculty and/or faculty of color.
- Take partners' employment needs seriously and treat all partners with respect.
- Be aware that it is illegal and counterproductive to ask candidates questions about their personal lives.

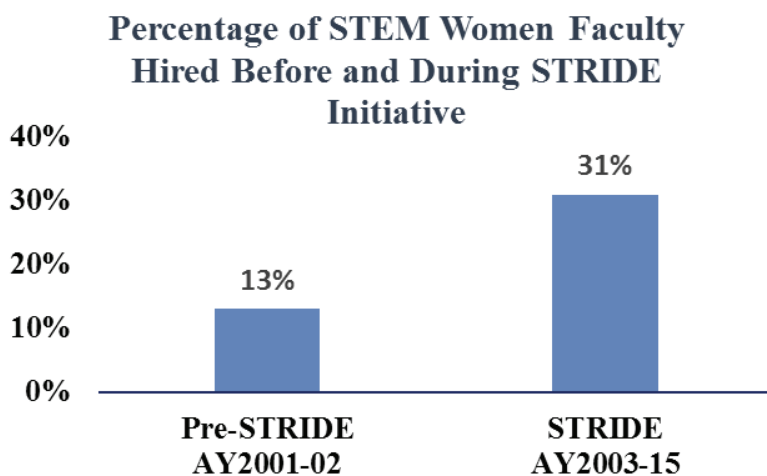


FIGURE 3-2 Hiring outcomes of the STRIDE Program.

SOURCE: University of Michigan.

The next task was to change the culture related to retention. A network for women faculty supported positive collective identity, surfaced issues, and created a peer mentor system. “Most faculty were isolated in their units, and this created a community,” Malley said. “Friendships and scholarly collaborations have developed as a result.”

Another early effort was to provide support and guidance to new junior faculty, although Malley commented they were warned not to use the term “mentoring” because senior professors considered it applicable to graduate students and not faculty. They set up “launch or advising committees” that consist of a senior faculty member within the department with similar research interests, the department chair, a senior faculty member outside the department but in a field with related research interests, an ADVANCE faculty member, and the new junior faculty member.

Campuswide assessments of climate are conducted. A negative climate is associated with faculty intentions to leave an institution, Malley explained. A baseline assessment took place in 2001 and every 5 to 6 years since to look at such factors as institutional climate, departmental climate, and career satisfaction. In all data collection, white males report the most positive climate. The Respect in Striving for Excellence, or RISE, initiative has adopted STRIDE’s model of faculty/staff collaboration and coeducation to develop resources to promote respectful and inclusive faculty work environments and address the issues surfaced by unit climate assessments.

Significant policy changes include annual monitoring of data by leaders, recruitment-related policies, increased family-friendly policies, and a more flexible tenure clock. Overall, the lesson learned is that change is slow and the efforts must be maintained over a long period, especially in a large institution. Organizational culture is a product of many different interactions and processes. Leadership must occur at all levels, including the top of the institution, departmental level, and among individual faculty.

SUPPORTING STRUCTURAL CHANGE PROGRAMS

Alice Hogan, now an independent consultant, was the founding project officer for the NSF ADVANCE Program, of which the University of Michigan was in a cooperative agreement (see previous presentation). ADVANCE began in 2001 in recognition that many years of increasing numbers of women Ph.D.’s in STEM fields saw no corresponding rise in the number of women full professors. The focus was on the role institutions of higher education play in the career success of women faculty in science and

technology. Funding developed data-informed interventions. ADVANCE sought to develop systemic approaches to increase the participation and advancement of women in academic STEM careers. Similar programs have been supported through the European Commission.

NSF legislation requires attention to “who does science.” This legislative mandate is helpful to give NSF the ability to undertake a program like this. Cooperative agreements with universities were based on mutually agreed-upon goals and commitments.

Data showed that marginalization of women faculty was accompanied by differences in salary and other benefits, and the pattern repeated itself in successive generations of women faculty. No one “black box” of knowledge will work, Hogan said, since each institution considers itself different. Having the data helps to connect knowledge and practice, build awareness of and address gendered aspects of institutional life, and practice and support learning and action. Lessons from structural change projects include that change is necessary, but not sufficient, to address structural exclusion. Status within organizations, clear engagement of the leadership, definition of short- and longer-term goals, and engagement of men are also important. Transformational agents are needed, although it is challenging work. The numbers for women in leadership positions (e.g., department head, dean) may change faster than women at the full professor level, she suggested. Establishing credibility is challenging and requires different approaches at each institution. Positive social outcomes can take years to take root.

ADVANCE provided toolkits, an information portal, and tutorials, among other resources. Related programs in the United States and Europe provided for mutual learning and cross-pollination, and papers on gender bias, unconscious assumptions, and implicit bias were published as a result of the project, as was the book *An Inclusive Academy* by Abigail J. Stewart and Virginia Valian.

EFFECTIVE PROGRAMS TO ATTRACT AND PREPARE WOMEN

Yasmine Kanaan, associate professor at the Howard University College of Medicine, drew on her own experience living in a refugee camp in Lebanon, attending a girls’ middle school, and being the only girl in her high school class to discuss encouraging young women to pursue careers in science. She noted the important role of a supportive father in her own career. She is now an associate professor at Howard University, where about 57 percent of the medical school is women, and most of them are African American.

Howard University has a long history of supporting women in the sciences but has also reached the current level of high female involvement through a number of efforts. It is important to start early to interest young women in science, Kanaan stressed. For example, Howard has a middle school in science and mathematics that helps create a pipeline of students. Outreach to other programs can also create opportunities for mentorships, including for young women from financially stressed situations who could later be eligible for scholarships. Other programs connected with Howard include the Howard University Science, Engineering, and Mathematics Program to increase the numbers of underrepresented minorities who receive baccalaureate and graduate degrees in STEM disciplines, the Howard Career Opportunities Program, the Bison STEM Scholars Program to attract and prepare high-achieving high school students to ultimately pursue a Ph.D. or a combined M.D./Ph.D., and the Minority Science and Engineering Improvement Program. The Semiconductor Research Corporation also provides undergraduates with valuable research experience and mentoring.

Overall, Howard University has found success in contacting organizations that attract young women and providing opportunities for the participants to spend time with a mentor in science. The mentoring period varies depending on the age of the student and area of interest. Financial support, especially for college, is important.

ASTRONOMICAL EVOLUTION THROUGH GRASSROOTS EFFORTS

Dara Norman, full scientist and deputy associate director of the Community Science and Data Center at the National Optical Astronomy Observatory, discussed efforts to increase the number of women and underrepresented minorities in astronomy. The numbers in physics and astronomy are small compared with other STEM fields, but are growing. In 2017, 33 percent of astronomy bachelor's degrees and 40 percent of astronomy doctorates went to women. Much of the growth can be traced to the grassroots efforts of those interested in changing the field, she stated. As the number of white women in the field has grown, representation is still poor for minorities, especially for women of color. To be inclusive requires removal of barriers to access, creation of inclusive climates, establishment of a community of inclusive practice, and improved access to policy, power, and leadership.

A grassroots effort called Inclusive Astronomy 2 took place in Baltimore recently. The focus of it and other grassroots efforts is to provide advice to minority students to enter Ph.D. programs. Norman also noted support for bridge programs and an effort to urge schools to place less reliance on the Graduate Record Examination, or GRE, which cuts off a lot of women who would otherwise do well at the graduate level.

The Committee on the Status of Women in Astronomy of the American Astronomical Society has taken on sexual harassment. These efforts have brought awareness and legitimacy to community concerns, and established organizations (professional societies, departments, and funding agencies) are moving to support the improvement of representation. For example, the committee found that women had more difficulty in winning time on telescopes at observatories for their research. To counter this, Hubble [Space Telescope] started to do dual anonymous reviews, and The National Aeronautics and Space Administration (NASA) also decided to conduct dual anonymous reviews once it saw how well the Hubble process worked. A goal for the future is to tie research funding to progress on inclusion, Norman added. For example, the National Academies of Sciences, Engineering, and Medicine's Decadal Survey on Astronomy and Astrophysics 2020 will include recommendations related to diversity in policies, practices, and assessments.

DISCUSSION

Continuing a theme from earlier in the workshop, several people brought up the importance of making allies of males and how to do so. "You can't get things done without involving the people in power, and those people tend to be men," one participant said. "Convening women is important, but the bubble doesn't get burst outside." She asked how men became allies at the University of Michigan and at NSF. For ADVANCE, which needed to get clearance throughout NSF, each with its own needs, using the language of other programs was important, said Hogan. Malley said, "What was key for our program [at Michigan] was to go slowly and identify people who could be supportive. The advocacy of and participation of [male] respected scientists in STRIDE was key." Having the support of high-level administrators was also important, she added. They focused their energy on colleges and departments where they had strong support, rather than on units where they did not.

A participant raised the point that mentoring is also needed at the associate professor level—that is, at midcareer and not just for junior faculty.

That stage is where a lot of uncertainty happens, she observed. The University of Michigan has a program called LIFT (Leadership and Integration at Faculty Transitions) for newly promoted associate and full professors to discuss their new responsibilities and privileges, and can also provide leadership coaching, Malley said. An unanticipated benefit of the launch committees for junior faculty, she said, is that other faculty become better mentors. Huda Akil, who has been involved in STRIDE as a professor at Michigan, said she welcomed STRIDE's emphasis on implicit bias in committee and other group work. In addition to STRIDE's style and data-based approach, she praised the awareness raising about dynamics in a room. Strong voices can be dismissive, for example, or certain people will always talk first and thus have an unequal influence on decisions.

Another idea raised was to determine how gender could be part of the accreditation process. One participant shared that the Medical Research Council in the United Kingdom now requires that applicants for funding meet one of the Athena SWAN (Scientific Women's Academic Network) stages that seeks more gender equality.²

Another participant pondered how to change the culture in an institution without starting from scratch. "Look for solutions that are easy to implement," one person suggested. For example, senior administration officials would respond to ranking and accreditation, she added. Norman noted that in astronomy, the younger generation has taken upon itself to make changes related to codes of conduct. "Having data is important as an entry point, but you also need the stories of lived experience," suggested Hogan, noting there is no magic wand to progress.

KEYNOTE ADDRESS: THE ROAD FROM DAMASCUS— PERSONAL AND SCIENTIFIC JOURNEY

Noted scientist and 2015 recipient of the Kuwait Prize Huda Akil drew on her own experiences and research as a neuroscientist to highlight how women, including Arab women, can become STEM leaders. She said the workshop itself was hopeful in seeing talented and smart women work together to explore how to do better for other women and for humanity in general.

Akil grew up in Damascus, Syria, and came to the United States for her education and career. Her father had a large influence in her life and

² For more information, see <https://www.ecu.ac.uk/equality-charters/athena-swan>.

supported her goals, which launched her conviction that men have a role to play as allies in women's success in STEM and other fields. He respected her curiosity and took her questions seriously, she recounted. When he did not know an answer to one of her questions, he sought help from others. Through him, she learned an inquiring mind is the result of the interplay between genes and the environment, and families play a big role. Another large influence was a biography of Marie Curie that Akil read while in the fourth grade. Curie's life made her realize that a woman could move to a country like France and make discoveries in partnership with her husband.

In 1960, Akil's father wrote a letter with a vision for the future for his daughters and all girls. He wrote that the "world of tomorrow" would open doors to women and become stronger and richer as a result. She realized later how unusual were his views for a man, especially from the Mideast but also in the United States. She also noted his emphasis on education not just to get a job but also to acquire knowledge and ideas. His support countered the negative voices around her that a female is lesser than a male.

Akil attended American University of Beirut. Her family tried to arrange a marriage for her, but she came to realize she was trying to fit into a mold that was not her. Finally, her father agreed with her dream to study in the United States. In 1968, she went to the University of Iowa, then did her Ph.D. work at the University of California, Los Angeles, and post-doctoral work at Stanford University. In both places, male mentors played a huge role in taking her seriously, providing opportunities, and setting high expectations for her work. "I was lucky with these people in my life," she said. A more generalized lesson, she noted, is that "men are really important in enabling or squashing women in science."

At the University of Michigan, Akil and her husband, Stanley Watson, study the neurobiology of stress, addiction, pain, and depression. They are strong believers in team science across institutions, which is an approach, she observed, that enables women. As science requires the use of bigger teams in wise and thoughtful ways, the teams can be more flexible and accommodating to lift and support both women and men.

Also relevant is their research into the biology and psychology of individual differences and how individuals cope with the environment and build resilience. Surviving in science, especially for women, requires resilience. A related topic that needs to be discussed to prevent attrition relates to risk-taking. As discussed at various points during the workshop, many women take less risky career paths. When does this happen, and how much is genetic and how much is environmental? she asked. In the lab, female rats

take as many risks as males. Resilience was important to her own career, and she urged its importance for others. Women are acculturated to take fewer risks; yet to be resilient means to take risks, be wrong and survive, and not just please everyone. She went into a new field of science not scared of being wrong. Teaching women to take risks would empower them.

A multiscale approach is necessary, with many interactions and elements that are interrelated. She also urged people to think about happiness and brain health.

Akil urged the following considerations for every girl and woman in her intellectual pursuits:

- Listen to her and tell her that her mind matters.
- Help her imagine possibilities.
- Teach her to take intellectual and personal risks.
- Mentor at every stage.
- Let her discover her strengths, build resilience, and understand power and use it for the greater good.

In the end, these values derive from humanism. Akil's father's feminism, before that term really existed, stemmed from his humanism, she said. She concluded by describing herself as a scientist who is optimistic that valuing everyone's talents will move the world forward.

4

Curricula Structure and How It Affects the Attrition of Women in STEM in the United States, Kuwait, and the Arab World

As noted, the gender composition of science, technology, engineering, and mathematics (STEM) fields varies across time and space. Some surprising patterns include stronger gender segregation in some STEM fields in North American and European countries than in poorer and reputedly more gender-traditional societies. The final session of formal workshop presentations, chaired by Hala AlEssa (Kuwait University) and Maria Charles (University of California, Santa Barbara), explored how characteristics of primary and secondary schooling and curricula may influence the gendering of STEM skills and aspirations in diverse contexts. Possibly relevant educational characteristics, some of which were explored during the presentations, include curricular content, graduation requirements, tracking and placement practices, curriculum standardization, single-sex schools, school demographics and resources, and extracurricular programming.

Abrar Al-Alwadhi (Kuwait University), Hessa Amin (FAWSEC Educational Company), and Zaha AlSuwailan (Kuwait University) presented on policies and practices in Kuwait. They were followed by a U.S.-focused panel that consisted of Claudia Buchmann (The Ohio State University), Yingyi Ma (Syracuse University), and Chandra Muller (University of Texas at Austin). A final discussion session wrapped up the workshop.

OPPORTUNITIES OF KUWAITI FEMALES IN STEM UNDERGRADUATE MAJORS

Abrar Al-Alwadhi, assistant professor of special education at Kuwait University (KU), reiterated a point made throughout the workshop: More females than males major in STEM fields in universities in Kuwait (and other Gulf states). She described the paths to a STEM education in the country, whether through the public KU or through scholarships from the Ministry of Higher Education to local private universities or to study internationally.

Admission to KU requires a high school diploma obtained on either a science or humanities track, an aptitude exam, and a minimum high school grade point average. The percentage of STEM students to the overall student body has dropped since 2010–2011, from 42 percent to 29 percent (see Figure 4-1). This is partly because the overall number of students graduating has increased, but there has been a drop in STEM versus non-STEM graduates. Some factors to explain the decrease include transfer to other majors or to other universities, as well as dropping out from higher education all together. In addition, the workforce in science and research is as low as 12 percent in Kuwait, Qatar, and the United Arab Emirates, according to an article in the *World Journal of Education*.¹

Looking at gender, there has been a 70 percent drop in admitted males in STEM subjects since 2010–2011. There has been a 21 percent increase in STEM female versus male students over the past 7 years and a corresponding slight increase in the percentage of females versus males graduating as STEM majors.

The Ministry of Higher Education requires a diploma in either a science or humanities track and a grade point average minimum in its requirements for scholarships. Most of those who receive scholarships major in science. In 2018, for example, 2,159 international scholarships in science and 195 in nonscience were awarded, as well as 2,963 local scholarships in science and 785 in nonscience.

Most international science scholarship students are males, while most local science scholarship students are females. In 2018, 1,434 males received international scholarships in science majors compared with 725 females. Locally, 1,723 females received scholarships to study STEM subjects at private universities within Kuwait, compared with 1,240 males.

¹ Islam, S. 2017. Arab women in science, technology, engineering, and mathematics fields: The way forward. *World Journal of Education* 7(6):12-20. DOI:10.5430/wje.v7n6p12.

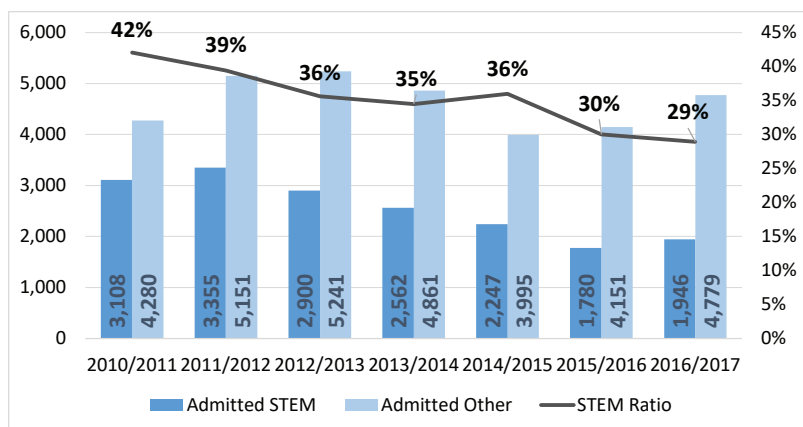


FIGURE 4-1 Kuwait University—admitted students in STEM and other majors (2010–2016).

SOURCE: Kuwait University.

Overall, to include KU and scholarship students, 53 percent of admitted students in STEM/science undergraduate majors are female and 47 percent are male. “So it is not the case that there are so many more women than men majoring in STEM,” Al-Alwadhi clarified, “but what we are finding is that most of the women are studying locally and not going internationally, whereas male students are going abroad.”

Women face a number of challenges in climbing the ladder. Those challenges include limited practical opportunities at universities in Kuwait to apply theoretical knowledge, lack of mentoring and networking, social obligations, productivity measured on a male scale, and male students’ stronger belief in their own creative thinking and problem-solving skills. “Programs like KEG [Kuwait’s Engineer Girls] (see Chapter 3) can help overcome these challenges,” Al-Alwadhi concluded.

MOTIVATING FACTORS FOR STUDENTS ENTERING IN STEM FIELD MAJORS IN KUWAIT

Hessa Amin, deputy chief executive officer of FAWSEC Educational Company, continued the discussion by describing a recent survey she and colleagues conducted. They posed three research questions: (1) What motivates and influences students to enter into STEM field majors? (2) Do the motivating factors look different for males versus females? (3) Do the

motivating factors look different for students attending private versus public high schools? They conducted a survey with 256 STEM students to ask them to rate their own motivating factors for entering the field, such as salary, prestige, influence by family or other people, and others. For each factor, respondents stated the factor had no effect, was a small factor in choosing the field, or was a major factor in choosing the field. University professors administered the online survey between July and October 2019. Most respondents were from KU and most were female.

“If we look overall, the number one factor was prestige,” Amin noted. “The second was high school subjects the student had taken” (see Figure 4-2). For males, a high salary and prestigious career were the two main factors, with high school subjects slightly lower.

These preferences held for students in public high schools, but those in private high schools indicated a larger role for parents’ influence. One reason for high school subjects not playing a larger role for private high school students may be that they do not have to choose a humanities or science track, while their counterparts in public high school do in 11th and 12th grades.

Analyzing the comments revealed that other motivating factors included personal interest and teacher instruction and/or encouragement. Parents can influence students in a positive way, such as a role model or through support and guidance, or through pressure to follow a STEM field.

In summary, Amin said, prestige was the main motivating factor for students entering STEM field majors. Females are more motivated by their high school studies, while males are more motivated by the financial returns of the field. Parents and teachers can influence students to enter STEM fields using different methods.

Future studies will explore the influence of high school tracking and the acceptance criteria for scholarships and KU on the selection of STEM field majors by women and men.

INVESTIGATING REPRESENTATIONS OF GENDER IN PUBLIC SCHOOL TEXTBOOKS IN RELATION TO STEM

Zaha AlSuwailan, assistant professor of education at KU, looked further back in students’ education to gender representation in primary school, middle school, and high school textbooks. “Students consciously or unconsciously observe and interpret the social, racial, and economic realities presented in photographs, images, drawings, and characters in their textbooks,” she said. Moreover, research has shown that textbooks,

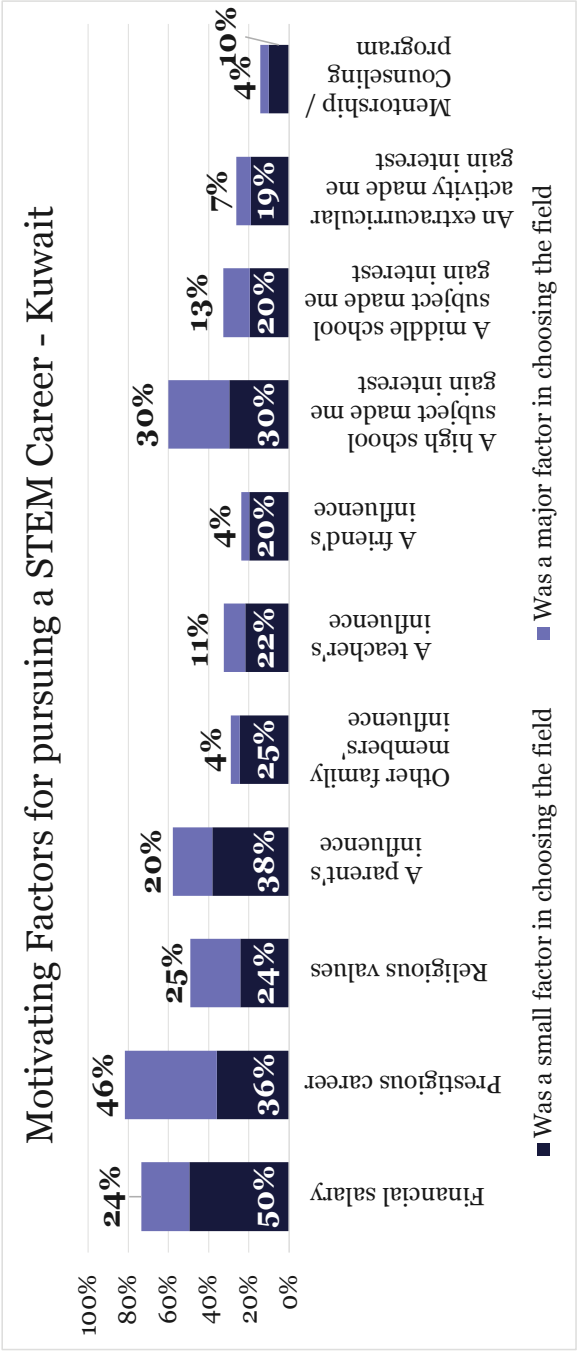


FIGURE 4-2 Motivating factors for pursuing a STEM career in Kuwait.
SOURCE: Data provided by Hessa Amin (FAWSEC Educational Company), Abrar Al-Alwadhi (Kuwait University), Zaha AlSuwailan (Kuwait University), and Dr. Fawzeyah Al-Awadhi (Kuwait University).

including the images used, can have an influence on values and social norms transferred to learners. Earlier textbooks in the Arab region emphasized traditional roles for women. However, an analysis of more recent books used in Kuwait's new curriculum, in light of the increasing numbers of females entering STEM fields, seemed in order.

AlSuwailan performed a content analysis of the Arabic, Islamic Studies, English, and social studies textbooks to identify the different representations of gender in relation to STEM. She looked at authors, the characters portrayed, images, and the plot or narrating story about prominent figures in STEM fields.

At the primary school level, 66 percent of the authors were female. The number decreased to 52 percent for middle school textbooks and to 48 percent for high school textbooks, although at each level, it varies by subject.

Characters mostly appear in the primary-level textbooks. In them, 54 percent of the characters were females and 46 percent were male. (By middle school and especially high school, characters were not present in the textbooks.) Regarding images, at the primary level, females were represented in 41 percent of the images versus men at 59 percent. In middle school, although the total number of images are far fewer, there were more female images than male. Finally, most plots appeared in the middle and high school textbooks. In middle school, females were in 40 percent of the plots, and in high school, 60 percent. An example was a middle school English textbook with an article about the U.S. Civil War nurse Clara Barton, which contains the explicit message that "women can succeed in any job."

In addition, images showed women in lab coats and in engineering capacities. Examples of notable women, both Kuwaiti and from other countries, are also present in the textbooks. To summarize, AlSuwailan said, "the textbooks in Arabic, English, and social and Islamic studies now portray the role of females in STEM fields in the 21st century."

DISCUSSION

The discussion session focused on similarities between the two countries, including how different factors can influence selection of a major. Textbooks can be encouraging, but barriers such as customs and family influence remain, one participant said. The role of prestige in choosing a major may explain the gap between the number of women studying STEM and those moving up in the field, another commented. She said she knows several women who majored in engineering for prestige reasons but are working in other fields.

“Only those who really have a passion are ready to face the challenges and compete with men to advance to the higher ranks,” she commented. But another participant, noting the existence of the so-called glass ceiling in the United States at the very top, countered, “I would caution on focusing on passion alone in moving up when there are structural barriers that are much more severe at a higher level.” Finally, it was noted that some medical fields tend to attract more women, such as pediatrics, family medicine, and obstetrics and gynecology in both countries. A World Health Organization World Health Study of the global health workforce shows that women make up 70 percent of overall workers but only 25 percent of leaders.²

Regarding the incentives for females and males to enter STEM fields, a participant noted that passion and prestige tend to be subjective and can change over time. In contrast, she noted, financial status is more quantitative. If finances are the main motivator, “maybe this is one reason why males continue in the workforce.” Culturally, males may feel more responsible to be financially secure than women, she posited. In many Islamic countries, one participant said, girls enter STEM fields that have a reputation of being challenging to show they can succeed in them. “That is a pattern in many developing countries. Young girls are fighters, they want to prove they can do it,” she said.

Listening to the data, a participant observed, the question is what to do next. “As I see it, the environment is filled with structural barriers,” she said, such as the larger numbers of Kuwaiti males who can study internationally, which could be related to individual girls’ choices or family expectations that girls remain closer to home. She added, “The idea of choice and ‘you can make it happen if you want to’ means that only a select few get to have the opportunities.” The role of individual choice versus structural barriers plays out in different cultures and contexts, participants agreed.

ALIGNING SCIENTIFIC ACHIEVEMENT AND FUTURE EXPECTATIONS FOR STEM CAREERS: ROLE OF CURRICULAR STANDARDIZATION

Claudia Buchmann, professor and chair of the department of sociology at Ohio State University, explained that 48 percent of students who begin

² Delivered by women, led by men: A gender and equity analysis of the global health and social workforce. 2019. Geneva: World Health Organization. <https://www.who.int/hrh/resources/health-observer24/en>.

STEM in U.S. colleges and universities either transfer to a non-STEM subject or drop out. A lack of preparation in science leads in part to these high rates of departure, even among those who enter higher education with a high degree of interest in the disciplines. “It is valuable in this context with this problem to think about how to increase the alignment between science performance and students’ aspirations,” she said. Buchmann and her colleague examined 27 industrialized countries to determine if the degree of standardization of the curriculum is related to the mean and distribution of science achievement, and to the alignment between science performance and aspirations. They also looked at gender gaps.

Curricular standardization is defined as the degree to which students are exposed to the same curriculum within a country. Of the 27 countries they studied, 7 are centrally mandated, 16 have a centrally mandated curriculum that allows for regional adaptation, and 4 (including the United States) have no centrally mandated curriculum.

Buchmann and her colleague posited that standardization may be beneficial in terms of performance and in reducing gender gaps in achievement and aspirations. In these standardized systems, all students are exposed to the same knowledge of science and math. They cannot opt out. By all students taking these courses before they enter college, they gather valuable feedback about their performance in math and science relative to their peers. High science achievers may gain added confidence about pursuing a STEM major. “This may be particularly valuable for the adolescent girls with confidence issues or the tendency for some girls to not think they are as strong as they are in science,” she said. In countries with less standardized curricula, such as the United States, students are getting more variable and weaker feedback.

Buchmann used the Programme for International Student Assessment, or PISA, 2006 dataset, conducted by the Organisation for Economic Co-operation and Development.³ Widely used in comparative research, previous iterations did not include any Arab countries, although more recent versions do, which will provide potential for future comparative research. Overall, science scores are significantly higher and more consistent in countries with standardized curricula, such as Finland and Japan, as well as other factors such as teacher quality and economic development. The evidence shows that curricular standardization is associated with higher science achievement, especially among girls. Looking at the subset of students

³ For more information on PISA, see <https://www.oecd.org/pisa>.

who indicated science as a career or major, student achievement is better aligned with expectations to pursue a STEM major or career in countries with higher levels of standardization, although the relationship between standardization and alignment is slightly weaker for girls than for boys, which is an area for further study. The United States trails many industrialized countries in science performance. This study suggests this gap is due, in part, to the lack of standardization in the science curriculum across U.S. states and school districts, Buchmann concluded.

INHIBITIONS TO WOMEN'S ENTRY INTO STEM AND POTENTIAL CHANGES

Yingyi Ma, associate professor of sociology at Syracuse University, looked at the process of underrepresentation by women in STEM fields, when it starts, if it is monotonic (underrepresented from precollege years, or does it start well represented and then become more of a retention issue?), and the switching of majors from STEM to non-STEM. To answer these questions, she looked at datasets from the National Education Longitudinal Studies (NELS), Pathways Through College data collected by the Wisconsin Center for Education Research, and her own work on Chinese international students in the United States over the past 7 years.

NELS data look at three points in time—high school seniors and their expected major, second year in college, and then bachelor's degree. In these data, the gender gap is largest in high school, when more males than females expressed the plan to major in STEM. Females, once they decided to major in a STEM field, are slightly more likely to persist. Overall, however, there is both gender and racial disparity in entry into STEM fields, as well as variation between life science and other STEM majors (see Figure 4-3). “By taking an intersectionality perspective, more complexity emerged, and breaking STEM fields into subfields also brings more complexity,” Ma observed.

In the Wisconsin Center for Education Research data, which is more recent than NELS, women were more likely to switch majors than men were (in both directions, from STEM to non-STEM and vice versa). One mechanism to focus on is the role of advising about their majors. Women are more likely than men to receive this type of advising. Science identity also played a role in changing majors. If a person “sees themselves as a science person,” he or she is more likely to stay in or switch to a STEM major, Ma said. For students who have received advising, an increase in science identity leads to significantly higher probability of changing to a STEM

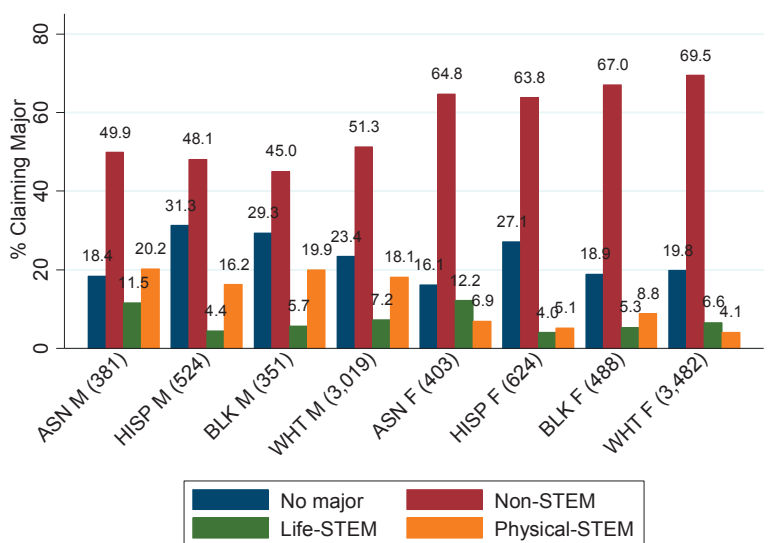


FIGURE 4-3 Gender and race disparity in entry into STEM fields (N = 9,272).

SOURCE: Ma, Y., and Y. Liu. 2017. Entry and degree attainment in STEM: The intersection of gender and race/ethnicity. *Social Sciences* 6(3):89.

NOTE: Data were sourced from National Education Longitudinal Studies (NELS:88-00) postsecondary transcript data. The sample consists of all the postsecondary participants, based on transcript data, who also identify as one of the four racial/ethnic groups: non-Hispanic whites, non-Hispanic Blacks, Hispanics, and Asians. The parentheses include the sample size for each group.

major, controlling for such variables as parental education, high school coursework, and college experience.

Ma conducted a mixed-method study of a new wave of self-funded Chinese undergraduates in the United States. Part of her work compares college major choice by these students with their U.S. peers and with their peers in China. Among the findings, more are likely to major in STEM in China than in the United States. Close to 50 percent of Chinese international students choose STEM in the United States. Double majors are increasingly prevalent, and the Chinese students tend to be “spanners” with a STEM and non-STEM (such as humanities) major.

In summary, reviewing the NELS and Wisconsin Center for Education Research data, as well as her own work, shows the following:

- Affective factors, such as expectation to major in STEM and science identity, are key to women's entry into STEM.
- The largest gender gap observed was the gap in expected college major, as measured in high school. College provides a second chance, particularly through advising and science identity.
- Study of Chinese international students shows that their entry into STEM, switching out of it, and double majoring are influenced by both American and Chinese educational contexts.

CURRICULAR PATHWAYS FROM SCHOOL TO THE STEM LABOR FORCE IN THE UNITED STATES

Chandra Muller, professor of sociology at the University of Texas at Austin, reported on some findings from the High School and Beyond Midlife Survey. It began with 27,000 high school students in the early 1980s and followed up with them in 2014. "My framework is that stratification starts in high school, continues with postsecondary study, and then people live gendered adulthoods." Rather than look at young adulthood and entry level, she said she moves to midlife, a critical time in the United States to make or break in terms of retirement well-being. This generation faced the technological revolution of the 1990s, after they had graduated, and had to adapt to a totally new workforce environment and economy.

The National Center for Education Statistics notes changes in trends in high school curriculum when comparing the class of 1990 with the class of 2009. Students in high schools can follow three general routes: standard, midlevel, and rigorous, with the rigorous route encompassing precalculus or higher, as well as biology, chemistry, and physics. Overall, more high school students followed either a midlevel or rigorous track in 2009 compared with those in 1990. Another important trend is the number of students taking math throughout high school, broken down by gender. Using their own datasets, in 1982, more than one-third (35 percent) of females did not take mathematics their junior and senior years, but the number was less than 10 percent (and slightly better than boys) in 2013. Math level has been found to be the single best predictor of bachelor's degree completion and also predicts science success, because it is a crucial building block.

To look at midlife, Muller and her colleagues looked at three STEM occupational areas: life sciences and health science, physical science and engineering (PSE), and mathematics and computer science. Men and women with PSE degrees have a 20 percent advantage of being in a PSE

occupation at midlife, and men are about 5 percent more likely to be in managerial positions. Women with a PSE degree have similar but smaller advantages over their peers with other postsecondary degrees. Mathematics and computer science degrees lead to these occupations, especially for men.

Looking at the American Community Survey and the High School and Beyond Midlife Survey, men hold a 30 percent wage advantage over women. Choice of occupation can explain only some of the gap. When looking at men and women in the same occupation, the gap narrows but remains. The High School and Beyond Midlife Survey shows a larger gap when factoring in family background, high school studies, and other factors. In fact, women without a strong STEM background fare worse in wages related to men.

“Remember that the economy has changed, and it will not stay static,” Muller said. “I urge us to look at a broader concern about the significance of STEM. People with STEM training could be more protected.” Reviewing trends from 1980 to 2008 shows that the middle of the wage distribution has declined, with fewer jobs in the middle, as manifested by the decline of the middle class. Job growth has occurred at the lower and higher levels. Those who worked in the middle area of the past will move into higher-income or lower-income jobs. A STEM background may provide access to higher-paying occupations, although some lower-skill jobs also use technology.

“Bad job” characteristics include part-time work, low wages, and no retirement benefits. Muller reported on a study that looked at the relationship between having a math background (defined as Algebra 2 or above) and a bachelor’s degree or above with having these bad job characteristics. Women without a mathematics background or bachelor’s degree had the greatest number of these characteristics at midlife, while men with a bachelor’s degree were least affected. The study also found that women with a bachelor’s degree did not fare much better than men without one.

The series of studies led Muller and colleagues to make the following conclusions and raise priority questions for future study:

- The canonical STEM pipeline is not supported by evidence. Just because a woman has a STEM degree, she may not be doing better at midlife than a man without one.
- College preparatory high school coursework, especially in STEM, has been at parity since the 1980s and now favors women. Yet women are not entering STEM fields. The gender gap cannot be

explained by fields of study in higher education or by early adult work and occupations. Thus, beyond education, what processes are producing this gender inequality across workforce outcomes?

- STEM skills appear to be important for women across the labor force, and STEM curriculum is protective, especially for women. This raises questions about the role of STEM education in women's well-being and ability to adapt to economic transformation over the life course and especially as they age.
- Gender inequality is intersectional. What is the role of STEM for women and men at the intersection of other dimensions of inequality, such as race, ethnicity, and socioeconomic status?

DISCUSSION

In considering some of the reasons that U.S. science achievement is not higher, it was noted that the U.S. population is extremely heterogeneous, and the educational system is highly decentralized in how it is organized and funded.

A participant commented that the midlife gap discussed by Muller exists in Kuwait, too. We need to collect data to understand the reasons women drop out. Having a better sense of the contributions women have made in STEM would also be useful, another suggested, such as published papers, patents, influence in the media, and other measures.

A major challenge is the need for more transparency. A participant noted gender data for countries in the Arab region are often missing in international datasets, such as those compiled by the United Nations. Regarding implementation, a participant noted that the National Science Foundation ADVANCE Program promoted women's participation and queried how such a program could work in Kuwait. Science policy is thriving in the United States, she noted, and wondered about a larger role for scientists in policy in the Arab world.

Looking at the region, participants made several points. First, one participant observed that Kuwait plays a strong role in STEM education for those from other Arab countries, which may be useful to examine. Second, the American University of Beirut is trying to address the low numbers of women faculty by creating a senior-level position, namely, vice president for diversity, with decision-making power to lead efforts for diversity. The American University of Beirut is also creating a gender-sensitive data management system that deans in the separate colleges will be required to

provide. “When you have the data, you can track progress and understand what is going on,” she said.

A participant commented about the mentorship, grant-writing, advice about establishing a lab, and other programs at the University of California, Los Angeles, in the United States, where she was before coming to KU. This could be useful for new female and male faculty, she suggested. Suggestions of themes for a future workshop include retention, the role of family, ideas about gender roles, and cultural beliefs. Others included identifying national-level research plans and policies that could help inform career advice to students to understand the growing areas of demand. New career paths outside of academia would also be a good topic. Hearing from students would be valuable at a future workshop, another person suggested. “How do they see the future? What obstacles do they see in their way?” she said. Several participants also suggested the importance of finding ways to include men and to make men aware of the issues and research brought up during the workshop.

Appendix A

Workshop Agenda

October 28–29, 2019
National Academy of Sciences
2101 Constitution Avenue
Washington, D.C.

Monday, October 28, 2019

Room: NAS 120

9:00 – 9:30 AM

Welcome by Committee Chairs

Hayfaa Almudhaf, Senior Advisor, Kuwait Institute
for Scientific Research (KISR)

Sapna Cheryan, Professor of Psychology, University
of Washington

Opening Remarks from the National Academies Leadership

Jim Hinchman, Acting Executive Officer, National
Academies of Sciences, Engineering, and Medicine

Opening Remarks from KFAS Leadership

Dr. Adnan Shihab-Eldin, Director General, Kuwait
Foundation for the Advancement of Sciences

Opening Remarks from the Kuwait Embassy in the U.S.

Nawaf Al-Enezi, Deputy Chief of Mission, Kuwait Embassy in the U.S.

9:30 – 9:50 AM

Background Knowledge: Women in STEM Kuwait and the U.S.

Perspective from Kuwait

Hayfaa Almudhaf, Senior Advisor, KISR

Perspective from the U.S.

Sapna Cheryan, Professor of Psychology, University of Washington

9:50 – 10:40 AM

Session 1: The challenges and barriers facing women to enter and thrive in the science, engineering, and medical professions in both the U.S. and Kuwait

Session chairs: Ameenah Farhan, Kuwait University;
Sapna Cheryan, University of Washington

- **Future road map for the impact of Arab women in STEM Fields: Challenges and opportunities**

Nagwa El-Badri, Zewail City of Science and Technology, Egypt

- **How to lead female researchers in a masculine community**

Malak Abed, King Abdulaziz City for Science and Technology, Saudi Arabia

- **Narratives of women in a man's world: A sociolinguistic case study of engineering students in Kuwait**

Munirah AlAjlan, Kuwait University

10:40 – 10:55 AM

Q&A and Discussion

Moderators: Nour AlSabeeh, Kuwait University;
Sapna Cheryan, University of Washington

10:55 – 11:10 AM

Coffee Break

11:10 AM – 12:00 PM	<p>Session 1 - Continued: The challenges and barriers facing women to enter and thrive in the science, engineering, and medical professions in both the U.S. and Kuwait</p> <ul style="list-style-type: none"> • The acquisition and consequences of the “brilliance=men” stereotype Lin Bian, Cornell University • Challenges of Black women in the health-care industry Adia Wingfield, Washington University in St. Louis • Gender and careers: Work-family challenges, choices, and interventions Erin Kelly, Massachusetts Institute of Technology
12:00 – 12:15 PM	Q&A and Discussion
12:15 – 1:15 PM	Lunch
1:15 – 2:00 PM	<p>Session 2: Evidence of effective programs, practices, and models in both countries for recruiting women in science, engineering, and medicine</p> <p>Session chairs: Hayfaa Almudhaf, KISR; Sonya Smith, Howard University</p> <ul style="list-style-type: none"> • Beacon on a hill: From AUB to the Arab world influencing a region one STEM project at a time Lama Moussawi, American University of Beirut • Pioneering the empowerment of young female engineers in Kuwait Amani S. Bu-Qammaz, Kuwait University • Perceived macro and meso barriers to Kuwaiti women’s career advancement Ikhlas Abdalla, Kuwait University
2:00 – 2:30 PM	<p>Q&A and Discussion</p> <p>Moderators: Alia Marafie, Kuwait University; Sonya Smith, Howard University</p>

2:30 – 3:00 PM	Coffee Break
3:00 – 4:00 PM	<p>Session 2 - Continued: Evidence of effective programs, practices, and models in both countries for recruiting women in science, engineering, and medicine</p> <ul style="list-style-type: none"> <p>Efforts to identify and implement data-driven policies and practices that increase diversity and retention Janet Malley, University of Michigan</p> <p>Improving the inclusion of women in science, technology, engineering, and mathematics; supporting structural change programs Alice Hogan, Independent Higher Education Consultant</p> <p>Effective programs to attract and prepare women to major in a science-related discipline Yasmine Kanaan, Howard University</p> <p>Astronomical evolution through grassroots efforts Dara Norman, National Optical Astronomy Observatory (NOAO)</p>
4:00 – 4:30 PM	Q&A and Discussion
4:30 – 5:00 PM	<p>Keynote Address The Road from Damascus: Personal and Scientific Journey Huda Akil, Co-Director and Research Professor, MBNI; Distinguished University Professor; Quarton Professor of Neurosciences; Department of Psychiatry, University of Michigan, Ann Arbor</p>
5:00 – 6:30 PM	Reception

Tuesday, October 29, 2019

Room: NAS 125

- 9:00 – 11:00 AM **Session 3: Curricula structure and how it affects the attrition of women in STEM in the U.S., Kuwait, and Arab world**
Session chairs: Hala AlEssa, Kuwait University;
Maria Charles, University of California, Santa Barbara
- 9:00 – 9:45 AM
- **Opportunities of Kuwaiti females in STEM undergraduate majors**
Abrar Al-Awadhi, Kuwait University
 - **What are the motivating factors for students entering STEM field majors in Kuwait?**
Hessa Amin, FAWSEC Educational Company
 - **Investigating representations of gender in STEM in school textbooks in Kuwait**
Zaha AlSuwailan, Kuwait University
- 9:45 – 10:15 AM **Q&A and Discussion**
Moderators: Hala AlEssa, Kuwait University;
Maria Charles, University of California, Santa Barbara
- 10:15 – 10:30 AM **Coffee Break**
- 10:30 – 11:15 AM **Session 3 - Continued: Curricula structure and how it affects the attrition of women in STEM in the U.S., Kuwait, and Arab world**
- **Aligning students' science achievement and expectations to pursue STEM careers: The role of curricular standardization**
Claudia Buchmann, Ohio State University
 - **What inhibits women's entry to STEM fields and what could change it?**
Yingyi Ma, Syracuse University
 - **Curricular pathways from school to STEM labor force in the U.S.**
Chandra Muller, University of Texas at Austin

11:15 – 12:00 PM **Q&A and Discussion**

12:00 – 1:00 PM **Lunch**

1:00 – 3:30 PM Debrief and planning for Kuwait 2020 workshop
(organizing committee and staff only)

Appendix B

Biographies of Planning Committee Members

Hayfaa Almudhaf (Committee Co-chair) played a key role in the initiation of the National Academy of Sciences (NAS) Arab American Frontiers Program, and in hosting the first conference in Kuwait in 2011. Before retiring, Ms. Almudhaf was a senior advisor at the Kuwait Institute for Scientific Research (KISR) since 2008. She has been actively involved in scientific research for 18 years in disciplines related to building and energy efficiency, resulting in more than 50 technical reports and scientific papers. She has also held the position of manager of the Building and Civil Engineering Department at KISR. Ms. Almudhaf was a member of the Founding Board of Directors for the Environment Public Authority (EPA) in Kuwait. She was the chairperson of the Higher Organizing Committee of the International Conferences on Women Leaders in Science, Technology and Engineering in 2007.

Sapna Cheryan (Committee Co-chair) is a professor of social psychology at the University of Washington. Her research investigates the role of cultural stereotypes in causing and perpetuating racial and gender disparities in U.S. society. In 2009, Dr. Cheryan received the National Science Foundation CAREER Award. In 2012–2013, she was a visiting scholar at the Russell Sage Foundation in New York City, and in 2016–2017, she was a Lenore Annenberg and Wallis Annenberg Fellow in Communication at Center for Advanced Study in the Behavioral Sciences (CASBS) at Stanford University. Dr. Cheryan currently serves on the Social Science Advisory

Board of the National Center of Women in Information Technology and on Mattel's Global Advisory Council. She earned her Ph.D. in psychology from Stanford University in 2007.

Hala AlEssa is an assistant professor with the Department of Public Health Practice at Kuwait University. She is also a visiting scientist at Harvard T.H. Chan School of Public Health in the Department of Nutrition. Dr. AlEssa is a member of the American Heart Association, Kuwait Heart Association, and the American Dietetic Association. She received her B.S. in dietetics and nutrition from Purdue University. She has a master's degree in epidemiology from Harvard University, and a doctorate in public health nutrition from Harvard University.

Maria Charles is a professor of sociology, director of the Broom Center for Demography, and faculty affiliate in the Feminist Studies Department at the University of California, Santa Barbara (UCSB). Her research explores gender inequalities around the world and the cultural and structural forces that sustain them in families, educational systems, and labor markets. She has published extensively on the phenomenon of gender segregation, most recently on the ideological and organizational factors that contribute to women's underrepresentation in science, technology, engineering, and mathematics (STEM) fields around the world. Dr. Charles is an elected member of the Sociological Research Association and the recipient of numerous research awards and grants for comparative work on gender segregation and gender belief systems. Before arriving at UCSB, she served on the sociology faculty at UC San Diego, and was a postdoctoral researcher at the Swiss Federal Institute of Technology in Zurich. She received a Ph.D. in sociology from Stanford University, and bachelor's degrees from UCSB in environmental studies and political science.

Ameenah Farhan is currently the head of the Physics Department at Kuwait University. She serves as a senior advisor to the director general at the Kuwait Foundation for the Advancement of Sciences (KFAS) and on the Board of Trustees of the Jaber Al-Ahmed Center for Molecular Imaging and Nuclear Medicine. She was also the vice dean for research and laboratories affairs in the Faculty of Sciences at Kuwait University. Her research interests include nuclear structure and astrophysics, nuclear data evaluation, and environmental radioactivity, where her contributions have led to several publications in these fields. She is also a member of the American Physical

Society and the American Association for the Advancement of Science. Since 2015, she has served as a jury member with L'Oreal-UNESCO for Women in Science–Middle East. Professor Farhan is passionate about, and is an advocate for, physics education, especially in its promotion and enhancement at the undergraduate and graduate levels.

Sonya Smith is a professor of mechanical engineering at Howard University, being the first tenured female faculty member and the first woman promoted to the highest academic rank of professor (full) in the Department of Mechanical Engineering at Howard University. Since joining the faculty in 1995, Dr. Smith has established an interdisciplinary theoretical and computational fluid dynamics research program. She has received research grants from NASA, the U.S. Department of Defense, and industry to conduct research on topics in atmospheric turbulence, aeroacoustics, vortex-wake aircraft encounters, simulation of wake vortex dynamics, and rotorcraft icing severity and detection. Dr. Smith also conducts research in computational neuroscience. For more than 4 years she has collaborated with the National Institute on Deafness and Other Communication Disorders (NIDCD). She is an active member of the Association for Research in Otolaryngology (ARO) and has presented at each of its meetings since becoming a member. She is also a member of the Diversity in Acoustics Committee of the Acoustical Society of America (ASA). Dr. Smith received her Ph.D. in mechanical and aerospace engineering from the University of Virginia.

Appendix C

Biographies of Speakers

Ikhlas Abdalla is a professor of management at Kuwait University. She is a graduate of Imperial College of Science and Technology, London University. She has wide academic and professional experience in the Arab region. Her main research interests are in management and organizational behavior with specific focus on leadership, human resources management, careers, gender, expatriations, and Arab socioeconomic issues such as employment and education.

Malak Abed AlThagafi is an American board-certified physician-scientist in clinical pathology, anatomical pathology, neuropathology, and molecular genetics pathology. She studied and worked in world-renowned universities, including Georgetown University; University of California, San Francisco; Stanford University; Johns Hopkins University; and Harvard University. She is a national and international awards winner in her field and has published more than 100 original and conferences papers. She was selected in 2018 and 2019 as one of the most powerful people around the globe in pathology and lab medicine by *The Pathologist*. Currently, she is the director and primary investigator of the Saudi Human genome lab at King Fahad Medical City (KFMC) in Riyadh, associate research professor at King Abdulaziz City for Science and Technology (KACST), medical director at King Faisal Specialist Hospital International (KFSHI), and founder of CID (a genomic startup company). Dr. AlThagafi hopes to improve the applica-

tion of personalized medicine and targeted therapy, which can be utilized in the clinical management of patients.

Huda Akil has made groundbreaking contributions to the understanding of the neurobiology of emotions, including pain, anxiety, depression, and substance abuse. Early on, she and her colleagues provided the first physiological evidence for the role of endorphins in the brain and showed that endorphins are activated by stress and inhibit pain. In investigations of the mechanisms underlying stress reactivity in anxiety and depression, she demonstrated that social defeat in rodents activates unique neural pathways resembling those altered in human depression. Dr. Akil and her team have focused on the role of specific genes and molecules in the pathology of mood disorders. These include the glucocorticoid receptor, which mediates the stress response, and the family of fibroblast growth factors (FGFs), which are critical for brain development. She, along with her collaborators, showed that the FGFs play a key role in shaping the vulnerability to anxiety and depression. Dr. Akil is one of the leaders of the Pritzker Consortium, which uses a combination of genetic, genomic, and neuroscience tools to discover the biological bases of major depression, manic-depressive illness, and schizophrenia. The goal is to both understand the causes of these illnesses and identify new targets for their treatment and prevention. Dr. Akil has received numerous honors and awards, including election to the National Academy of Medicine of the National Academies of Sciences, Engineering, and Medicine and to the American Academy of Arts and Sciences. In 2007, Dr. Akil received the National Association for Research on Schizophrenia and Depression Patricia Goldman Rakic Prize for Cognitive Neuroscience.

Munirah AlAjlan is an English as a Second Language instructor in the College of Engineering and Petroleum in Kuwait University (2008–present). She has an M.A. in applied linguistics from the University of Newcastle upon Tyne, and a Ph.D. in applied sociolinguistics from King's College, London. Dr. AlAjlan has researched Kuwaiti women who are studying engineering in Kuwait. Drawing on sociocultural linguistic and interactional perspectives, with focus on the small-story approach to investigate how the women constructed a female identity in engineering. Dr. AlAjlan's research interest falls in sociolinguistics, applied linguistics, and translation. She has been a member of the Pluricentric and NDV-Working Group (nondominant varieties) representing Kuwaiti Arabic (University of Graz, Austria). Dr.

AlAjlan published three conference proceedings (2011, 2012, and 2013) and presented many papers in the area of language, linguistics, and education. Currently, she is involved in a subtitling and translation project and a political narratives project.

Abbar AlAwadhi is an assistant professor of special education in the Department of Educational Psychology in the College of Education at Kuwait University. She earned an M.A. and a Ph.D. from Teachers College, Columbia University, in special education with a focus on intellectual disability and autism spectrum disorder. She has a B.S. in childhood/special education from Steinhardt School of Culture, Education, and Human Development at New York University. Her academic interest and research concentration is in early childhood development, general and special education development, inclusion, and the transition of individuals with disabilities from adolescence to adulthood. Dr. AlAwadhi also consults for the Ministry of Education and nonprofit organizations in Kuwait. She is a board member of the Special Olympics Kuwaiti team.

Zaha AlSuwailan is an assistant professor at Kuwait University in the Foundations of Education Department. She earned her Ph.D. from the University of Tennessee, Knoxville, in 2006 with a focus on philosophy of education. The title of her dissertation is “The Impact of Societal Values on Kuwaiti Women and the Role of Education.” She worked as a manager of the Education Development Centre. She is currently the coordinator of the Khalifa Award in Abu Dhabi. Her research interests are in philosophy and women’s education. She is a member of Phi Kappa Phi and the American Educational Studies Association. Dr. AlSuwailan received the Poster Award in Social Sciences in 2014 for her article “The Reasons behind Students’ Choices of Certain Majors and Its Impact on Society Needs.”

Hessa Amin is the deputy chief executive officer of FAWSEC Educational Company, a K–12 education company in Kuwait. In this role, Ms. Amin oversees Al-Bayan Bilingual School and Al-Bayan International School, as well as the FAWSEC support departments—human resources, professional development, information technology, education technology management, and admissions. Over the past few years, she has worked on several STEM-related projects, including co-creating new science standards with teachers, updating the methods of technology instruction, and planning and managing a schoolwide initiative to implement design thinking and

creative problem solving. Ms. Amin holds an M.Ed. in international education policy from the Harvard Graduate School of Education and a B.A. in business administration from the University of Washington, Seattle.

Lin Bian is the Milkman Evalyn Assistant Professor in the Department of Human Development at Cornell University. Before joining Cornell, she was a postdoctoral scholar in the Department of Psychology at Stanford University. She obtained her B.S. at Zhejiang University in China and her Ph.D. in developmental psychology at the University of Illinois at Urbana-Champaign. Her research examines the development of social cognition, with an emphasis on children's reasoning about social groups. In this vein, she has pursued two major lines of research: One line of work focuses on the acquisition and consequences of stereotypes about social groups for children's interests and motivation. The other line of work focuses on infants' and toddlers' sociomoral expectations, especially how they apply to behaviors within and across group boundaries.

Claudia Buchmann is a Distinguished Professor in the College of Arts and Sciences and chair of the Department of Sociology at The Ohio State University. She is internationally known for her research on gender inequalities in education, with a focus on how women have come to attain more education than men in most regions of the world today. She is coauthor of *The Rise of Women: The Growing Gender Gap in Education and What it Means for American Schools* (2013, Russell Sage Foundation), which was awarded the Otis Dudley Duncan Book Award by the American Sociological Association (ASA) Section on Sociology of Population and the Outstanding Book Award of the ASA Section on Inequality, Poverty, and Mobility. Her early research focused on educational processes and inequality in African societies, during which she received a Fulbright award to conduct fieldwork in Kenya. Dr. Buchmann's influential scholarship has been published in many top journals and has received widespread attention from the academic community and the news media, including *The New York Times*, *The Washington Post*, and National Public Radio. Dr. Buchmann is a member of the Sociological Research Association and a recipient of the Joan N. Huber Faculty Fellowship. Her research has been funded by the Spencer Foundation, the Andrew W. Mellon Foundation, and the National Institutes of Health. Dr. Buchmann received her B.A. from the University of Wisconsin and her Ph.D. from Indiana University.

Amani S. Bu-Qammaz is an assistant professor of civil engineering at Kuwait University. She received her Ph.D. in civil engineering from The Ohio State University in 2015; her M.S. in civil engineering from the Middle East Technical University, Ankara, Turkey, in 2007; and her B.S. in civil engineering from Kuwait University in 1999. Prior to pursuing her graduate studies, Dr. Bu-Qammaz joined a specialized training program for fresh graduate engineers and then spent 12 years working for the Ministry of Public Works, Kuwait. She was a specialist engineer when she left the ministry to join Kuwait University. Her research interests are in construction management, risk management, contract claims and extension of time, international construction, and decision-making analysis. In addition to her academic activities, Dr. Bu-Qammaz works as a consultant in the Public Authority of Manpower and participates as a member in governmental committees. Additionally, she has been working as the risk consultant for Kuwait International Airport New Terminal Project since 2016. Dr. Bu-Qammaz is the advisor and academic director of the Kuwait's Engineer Girls (KEG) project, a women's empowerment program established in 2017. KEG targets young female engineers in Kuwait to help them succeed in their future careers.

Nagwa El-Badri is the founding chair of the Biomedical Sciences Programs and the director of the Center of Excellence for Stem Cells and Regenerative Medicine at Zewail City of Science and Technology in Egypt. She has more than 100 publications and patents in the field of stem cells and regenerative medicine. She has established several undergraduate and graduate programs in Egypt and the United States in the fields of regenerative medicine, women's health, and gender medicine. She has received grants and awards from the American Heart Association, the National Institutes of Health, and the Science and Technology Development Fund of Egypt, and recently from the Women in STEM Exemplary Leader in Management Position Award by the Meera Kaul Foundation.

Alice Hogan served as the inaugural program director of the ADVANCE Program of the National Science Foundation (NSF). She was invited by the NSF Office of the Director to lead an effort to design, and then to implement, a new approach to addressing the underrepresentation of women in academic science and engineering careers, particularly at the senior ranks. This effort resulted in the creation of the ADVANCE Program. Ms. Hogan

served as the first program director of ADVANCE, from 2001 to 2007. Prior to work with the ADVANCE Program, she was a senior program manager with NSF's Division of International Programs with responsibility for strategic planning, oversight, and management of bilateral science and engineering programs with the People's Republic of China and other countries in the Asia Pacific region. She worked at the White House Office of Science and Technology Policy on detail from the foundation, with responsibility for a variety of international cooperative science initiatives, and at Motorola under a White House program, the President's Commission on Executive Exchange. Since her retirement from NSF, she has worked as an independent higher education consultant working with academic institutions on programs and policies to advance the participation of women in academic science and engineering. Ms. Hogan has served as an invited member of international advisory boards for European projects on women in science supported by the European Commission, including PRAGES, STAGES, GenderNet, and TRIGGER, and was a member of the European Commission Expert Group on Structural Change.

Yasmine Kanaan is an associate professor at the Howard University College of Medicine and the Howard University Cancer Center in Washington, D.C. She has authored and coauthored more than 105 publications and abstracts in breast and prostate cancer research. Dr. Kanaan has an extensive collaborative research effort in directions that delineate molecular differences in breast cancers among African Americans and Caucasians. The aim of her research efforts is to help identify ethnicity-specific markers for breast cancer progression and to develop a more tailored treatment approach, leading to better management of breast cancer in African American women. Dr. Kanaan's lab focuses on the following: (1) conducting research to refine the diagnostic criteria for the basal-like phenotype, particularly as related to cancers in African American women, while simultaneously identifying molecular features that can be used as markers and clues for further studies into the pathogenesis of these cancers; (2) developing novel approaches for prevention and treatment of breast and prostate cancers (together, these exploratory analyses will provide clues regarding specific chromosomal regions, and genes within those regions, which are important for this phenotype of breast cancer); (3) determining associations between metabolic syndrome and molecular profiles (particularly related to fat metabolism) in breast cancers of African American women; and (4) using breast cancer cell lines with gene expression patterns parallel to those of

major categories of basal-like breast cancer, to evaluate critical endogenous lipid metabolic pathways and endogenous growth requirements. Dr. Kanaan is an educator and has trained 12 doctoral students and served on various other doctoral candidate committees. Because of her academic accomplishments, Dr. Kanaan has been an invited speaker in several national and international venues.

Erin L. Kelly is the Sloan Distinguished Professor of Work and Organization Studies at the Massachusetts Institute of Technology (MIT) Sloan School of Management and is affiliated with the Institute for Work and Employment Research. Dr. Kelly's research investigates the adoption, implementation, and consequences of work-family and antidiscrimination policies in U.S. workplaces. She is part of the Work, Family & Health Network, which was supported by the National Institutes of Health and the Centers for Disease Control and Prevention. She has also investigated noncompliance with the Family and Medical Leave Act, how U.S. companies manage flexible work arrangements, and the effects of corporate affirmative action, diversity, and family policies on the representation of white women, women of color, and men of color in managerial and professional positions. Dr. Kelly received the Rosabeth Moss Kanter Award for Work-Family Research and has published articles in leading journals, including the *American Sociological Review* and the *American Journal of Sociology*. Prior to her appointment at MIT Sloan, she held the Martindale Chair in Sociology at the University of Minnesota and was an affiliate of the Minnesota Population Center and the Life Course Center. She was also a member of the graduate faculty at the Carlson School of Management. Dr. Kelly received her B.A. in sociology from Rice University and her M.A. and Ph.D. in sociology from Princeton University.

Yingyi Ma is an associate professor of sociology and a senior research associate at the Center for Policy Research. She is a sociologist of education and migration. Her work on STEM education focused on who studied in STEM fields and why, including the formation of aspirations, college major choice, and degree attainment in STEM fields. She has another strand of research on international education and has a forthcoming book on Chinese international students, titled *Ambitious and Anxious*, to be published by Columbia University Press. Dr. Ma received her Ph.D. in sociology from Johns Hopkins University in 2006.

Janet Malley is director of research and evaluation for the University of Michigan ADVANCE Program and is responsible for evaluations of all program initiatives, internal research studies, and climate assessments undertaken by the program. Prior to that, she was associate director of the university's Institute for Research on Women and Gender. She received her Ph.D. in personality psychology from Boston University and completed a postdoctoral fellowship at the University of Michigan's Institute for Survey Research. Dr. Malley has significant expertise and experience with quantitative and qualitative data analysis of institutional data.

Lama Moussawi is an associate professor at the American University of Beirut (AUB), conducting research and teaching in the field of management science. Dr. Moussawi graduated with a B.S. in computer science from AUB, an M.B.A. in supply chain management and a Ph.D. in management science from the University of Texas at Dallas. Dr. Moussawi teaches courses in decision modeling, supply chain management, business statistics, and operations management. Her research focuses on applications of operations research and management science in revenue management, inventory management, and supply chain management. In revenue management, she studies business problems with multidimensional capacity, such as the ones arising in the air cargo and cruise ship industries. In inventory management, she studies stochastic inventory models and deterministic periodic inventory models. Part of her research expertise is in coordinating decisions among supply chain partners to improve supply chain performance through designing coordinating supply contracts, under asymmetric information. Dr. Moussawi is actively involved in promoting and supporting women in data science. She is the founder and chair of the Women in Data Science (WiDS) conference at AUB, and the founding chair of the AUB Committee on the Lives and Careers of Women at AUB. She is also a co-principal investigator of a \$1.5 million funded research project to develop an index on the status of women in the formal economies in the Arab Middle East and North Africa region. She is actively engaged in issues related to women in operations research at the WOMRS (Women in Operations Research and Management Science) meetings at the annual international INFORMS (Institute for Operations Research and Management Science) conference, as well as the WIEA (Women in Industrial Engineering) workshops.

Chandra Muller is Alma Cowden Madden Professor in the sociology department at the University of Texas at Austin. Her current research

focuses on the long-run effects of high school coursework on midlife work and financial security, health, and political participation at the intersections of gender, race and ethnicity, social class, disability status, and immigration status. She is a principal investigator on the High School and Beyond Midlife Follow-ups and the National Study of Learning Mindsets. She has previously led studies of high school curriculum and effects on education and health (the Adolescent Health and Academic Achievement Study, which added an educational component to Add Health), and of post-secondary curriculum (which added a postsecondary transcript component to the National Longitudinal Study of Youth, 1997). Her elected memberships include the National Academy of Education, fellow of the American Educational Research Association (AERA), the AERA Grants Board, and the Sociological Research Association.

Dara Norman is a full scientist and deputy associate director of the Community Science and Data Center at the National Optical Astronomy Observatory (NOAO) in Tucson, Arizona. Her research interests primarily include active galactic nuclei—their triggering, environments, and influence on galactic evolution. She is also co-diversity advocate at NOAO, focusing on advancing efforts at NOAO/Association of Universities for Research in Astronomy to bring more underrepresented minorities and women into the “astronomy enterprise.” She has served on the governing board of the American Astronomical Society (AAS), been an active member of the AAS’s Committee on the Status of Minorities, chair of the Astro section of the National Society of Black Physicists, and is currently chair of the International Astronomical Union’s Working Group on Women in Astronomy. She has led efforts on the white papers “Significantly Increasing the Numbers of Minorities in Astronomy in the Next 10 Years” for the 2010 Astronomy and Astrophysics Decadal Survey and “Women of Color in Astronomy and Astrophysics” for the National Research Council’s (NRC’s) Women of Color in Academia 2012 Conference, and “Maximizing LSST’s Scientific Return: Ensuring Participation from Smaller Institutions” for the NRC’s Strategy to Optimize the U.S. Optical and Infrared System in the Era of the LSST panel. Dr. Norman holds M.S. and Ph.D. degrees in astronomy from the University of Washington and an S.B. in earth, atmospheric, and planetary science from the Massachusetts Institute of Technology.

Adia Harvey Wingfield is a professor of sociology at Washington University in St. Louis. Her research examines how and why racial and gender

inequality persists in professional occupations. Dr. Wingfield has lectured internationally on her research in this area, and her work has been published in numerous peer-reviewed journals, including *Social Problems*, *Gender & Society*, and *American Behavioral Scientist*. She recently completed a term as president of Sociologists for Women in Society, a national organization that encourages feminist research and social change, and is a regular contributor to *Slate*, *The Atlantic*, and *Harvard Business Review*. Dr. Wingfield is the author of several books, most recently, *Flatlining: Race, Work, and Health Care in the New Economy*, and is the recipient of the 2018 Public Understanding of Sociology Award from the American Sociological Association.

Appendix D

Workshop Discussants

Handy Abdulsalam

Department of Information Science
Kuwait University

Maryam Adnan

Kuwait Institute for Scientific Research

Feddah Ahmad

Health Sciences Center
AHC – Kuwait University

Mariam AlAwadhi

Faculty of Medicine
Kuwait University

Dalal AlFares

College of Arts
Kuwait University

Sabah AlMomin

Kuwait Institute for Scientific Research

Sharifa Alragam

Public Authority for Applied Education and Training

Nour AlSabeeh

Faculty of Medicine

Kuwait University

Dalal AlTaweel

Faculty of Pharmacy

Kuwait University

Lara Campbell

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Tiffany Chow

Department of Sociology

University of California, Santa Barbara

Catherine Riegler-Crumb

Department of Curriculum and Instruction

University of Texas at Austin

Jamie Curtis-Fisk

Dow Chemical Company

Melissa Ghim

National Institutes of Health

Hosnia Hashim

Kuwait Oil Company

Laura Lorenzoni

Ocean Biology and Biogeochemistry Program, NASA

Alia Marafie

College of Engineering and Petroleum

Kuwait University

Michaela Musto

The Clayman Institute for Gender Research

Antoinette Nelson

U.S. Agency for International Development

Yunzhi Zhan

World Bank

